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The Chicago Drainage Board will receive proposals until Jan. 25 for the excavation of sections A, B, C, and E, of the main drainage canal, between Willow Springs and Summit, and the dredging of the Illinois & Michigan Canal, between Summit and the south fork of the Chicago River, to enlarge it to give a capacity of 100,000 cu. ft. per minute. The work will include 7,200,000 cu. yds. of earth and 95,000 cu. yds. of rock excavation, 30,000 cu. yds. retaining walls, and 1,800,000 cu. yds. of earth dredging. Mr. Thomas Kelly has been elected a member of the Board, vice Mr. C. Hotz, who resigned last January.

Reports to the effect that the condition of the Boston water supply is unsanitary having been circulated recently, the Boston Water Board has just issued a special report regarding the present quality of the supply. The report appeared in the Boston papers of Nov. 28, and describes the present sources of supply, and what has been done and is being done to improve them, and keep the water pure. A table is presented giving by years the average results of chemical analyses of the water, made by Prof. T. M. Drown, Chemist of the Massachusetts State Board of Health, from June, 1887, to Nov. 1, 1892. Expressed in parts per 100,000 the average albuminoid ammonia has ranged from .0161 to .0207 for unfiltered, and from .0136 to .0178 in filtered water; the free ammonia has ranged from .0000 (the first nine months of this year), to .0008 from June, 1887, to May, 1889; nitrites have been low, and nitrates were .0090, the lowest during the period, the first nine months of 1890, and were at their highest in 1889, having been .0272 per 100,000.

The improvement of the harbor of Philadelphia is reported as making good though slow progress, by Maj. C. W. Raymond, U. S. Engineers, in charge of removing the islands in the river. He reports that 816,000 cu. yds. had been removed from Windmill Island, leaving about 422,000 cu. yds. to be yet excavated. Of this material 575,000 cu. yds. has been used in raising League Island, at the Navy Yard. The last surveys show that the piers can now be advanced, on the Philadelphia side, as soon as the War Department grants the necessary permission. The delay in excavating has been due in part to the wholly unexpected dicovery of a number of old wharves whose timbers have been buried for years on Windmill Island.

The repaving of streets by railway companies occupying these streets has been an issue in Philadelphia. The passenger railway companies originally contended that under the ordinances their only duty lay in keeping in repair that portion of the street lying between their tracks. This was contested by the city, and the Court of Common Pleas decided that the companies were bound to repave from curb to curb. The next question in controversy was the material to be used in repaving, the companies claiming that they were only bound to replace the original material, say cobblestone. The Court of Common Pleas again held, and this finding was confirmed by the Supreme Court, that under their charters and the city ordinances the city could decide upon the material to be used and the companies were bound to use such designated material. Under this last ruling a number of streets have been ordered paved at the expense of the railway companies. Some of the companies have paid their quota; others again are fighting the case on a question of measurements and street intersections.

Lake Angeline, near Ishpeming, Mich., has been pumped dry under the contract noted in our issue of March 26, 1892, as having been awarded to Mr. B. C. Howell, New York City. It is said that the maximum depth of the lake was 43 ft. Before beginning to pump the lake was lowered 5 ft. by draining into the Carp River. The pump used, it is said, had a capacity of 24,000 gallons per minute. The mining of iron ore from the bed of the lake will now be carried on.

The most serious railway accident of the week was a head collision, due to an open switch, on the Union Pacific Ry., near Alda, Neb., Nov. 22. A freight train was standing on the sidetrack, waiting for an express train to pass, but the crew had forgotten to close the switch, and the express was turned onto the sidetrack. There were four men killed and three injured, two fatally. None of the passengers were injured. Both engines and several freight cars were wrecked, and the baggage and mail cars were telescoped.

A steam heater in a pay car on the Knoxville, Cumberland Gap & Louisville R. R. exploded Nov. 25, fatally injuring two persons.

A part of a trestle on the Delaware & Hudson R. R., about 1½ miles north of Whitehall, N. Y., which was being used to close a break in the bank, sank down into the water Nov. 26.

Records of leaks in the long conduit of the waterworks of Rochester, N. Y., have been kept for many years and are summarized by months in the last annual report of Chief Engineer E. Kuichling, M. Am. Soc. C. E. This conduit leads from Hemlock Lake to the Rush reservoir and has a total length of 19.4 miles. The number of leaks by months for the periods named below are as follows, the record on the first part of the conduit being for a longer period than for the last part:

On 2,978 Miles (15.723 ft.) of Wrought Iron Riveted, and 6.775 Miles (35.772 ft.) of Cast Iron Conduit.

| | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Jan. 1, '80, to Jan. 1, '91 | 8 | 4 | 6 | 9 | 22 | 30 | 42 | 16 | 25 | 11 | 6 | 7 | 186** |
| Jan. 1, '91, to Jan. 1, '92 | 1 | 2 | 0 | 0 | 2 | 4 | 10 | 6 | 0 | 0 | 0 | 1 | 26*** |
| Total | 9 | 6 | 6 | 9 | 24 | 34 | 52 | 22 | 25 | 11 | 6 | 8 | 212 |

On 9.617 Miles (50,776 ft.) of 36-in. Wrought Iron Conduit.

| | On 9,617 Miles (50,776 ft.) of Wrought Iron Conduit. | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dec. 10, '77, to Jan. 1, '91 | 4 | 5 | 7 | 44 | 77 | 98 | 112 | 71 | 84 | 39 | 13 | 4 | 558 |
| Jan. 1, '91, to Jan. 1, '92 | 0 | 2 | 1 | 11 | 5 | 17 | 21 | 6 | 7 | 9 | 9 | 9 | 97 |
| Total | 4 | 7 | 8 | 55 | 82 | 115 | 133 | 77 | 91 | 48 | 22 | 13 | 655* |

* All these leaks appear to have occurred at lead joints; no record of breakage at riveted seams.
** 178 leaks at lead joints and 8 at riveted seams.
*** All at lead joints.

The flow of water through the conduit during the year remained quite constantly at about 7,000,000 gallons per day. The conduit was put in operation about the date of the first records of leak, or at least within a year of that date.

The large Shades Mountain Reservoir of the Birmingham (Ala.) Water-Works Co., on which work was suspended three years ago during the construction of its Cahaba River extension, has been completed and put into service. The suspension of work was due to apprehensions that, owing to the porous character of the rock, the reservoir, which covers about 13 acres, would leak. In order to obviate the difficulty thus presented a smaller reservoir was constructed adjoining the larger one. The apprehensions as to leaking have proven to have been groundless. We are indebted to Mr. W. J. Milner, Superintendent and General Manager of the company for this information. The Birmingham waterworks were described at length in our issue of Apr. 16, 1892.

The franchise has been granted by the New York Board of Aldermen to the East River Bridge Co., giving it the right to construct, operate and maintain the approaches to the two proposed bridges. The only conditions imposed were that a bond of $200,000 was to be given to save the city harmless from damages, and that the Commissioner of Public Works was to control the location of stations and stairways. Under the original act of the legislature, the city is to receive no compensation until the receipts average $3,000 per day on the bridge, and $4,000 per day on the railway. When this income is reached the cities of New York and Brooklyn are to divide 1% of the bridge receipts; the 1% from the railway will go to New York alone. For each additional $3,000 and $4,000 per day in income another 1% is to be paid. This franchise gives the bridge company a right to extend its railway approach across the city from the East to the North River, practically without any compensation, or without sale of this valuable franchise by auction, as the law provides. The general dimensions of these structures were given in our issue of Oct. 13, 1892.

In noting the report of Mr. Lewis Kingman, City Engineer of Topeka, Kan., on the proposed Topeka dam, the statement was made that under certain conditions 800 HP. was all that could be expected. This statement really referred to the Lawrence dam below Topeka. For $800,000 expended on the new dam 1,398 HP. could be secured, after deducting the loss at the wheel and for electric transmission. There is no question that 3,000 HP. could be now disposed of at Topeka at reasonable rates.

The New York Power Co. is asking the Board of Aldermen for permission to lay and maintain a system of pipes under the streets to supply compressed air and salt water under pressure "for power, ventilation and other purposes." The award of franchise is delayed because this company is really the successor to the National Heating Co., which absorbed the United States Heating and Power Co., which obtained a franchise in 1880. It is claimed that the insertion of the words "compressed air" into the old franchise converts it into an entirely new enterprise, demanding treatment as such.

Engineer Danforth, of the U. S. Navy, who refused to obey an order of the officer of the deck, has been suspended from rank and duty for one year, on the charge of "disobedience of the lawful orders of his superior officer." This is the sentence of the court-martial, now approved by Secretary of the Navy Tracy. Mr. Tracy, in his approval of the finding of the court, plainly lays down the rule that the officer of the deck, who is the representative of the commanding officer of the vessel, is entitled to "obedience from all officers of whatever rank, whether of the line or staff."

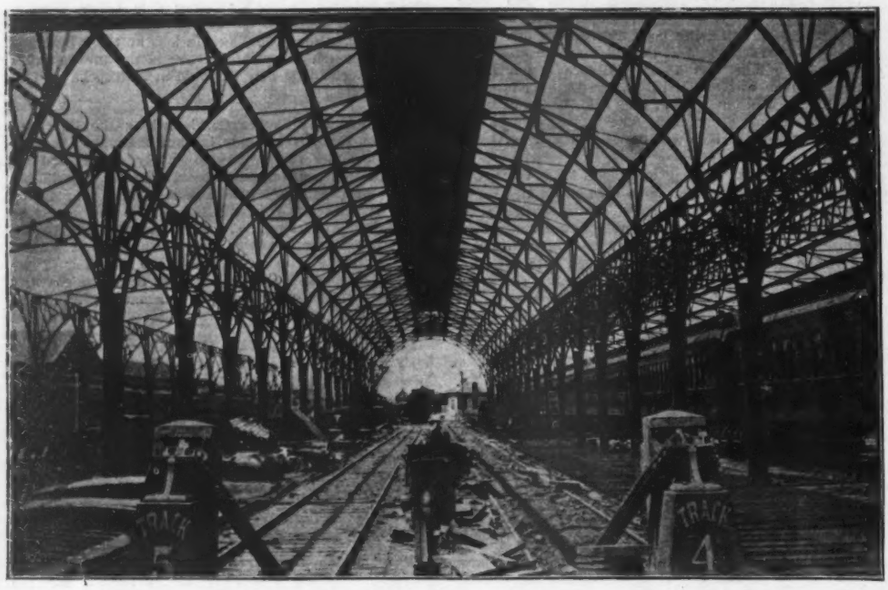
A report on the surveys for an Inter-Continental railway, recently issued by the delegates for the United States, shows very satisfactory progress on this work in Central and South America. In Central America the surveys have been completed in Guatemala, and are now in progress in Salvador; and in South America a line 2,800 miles long, running from the Caribbean Sea through Columbia, Ecuador and Peru to the western boundary of Bolivia, has been examined. The surveys show that perfect routes can be obtained, and the estimated cost of construction to vary from $16,000 to $48,000 per mile.

The iron works recently established by the Chinese Viceroy, Chang Chih-tung, near Hankow, are very large. They extend for about a mile along the bank of the Yangtze and are being fitted up with the most approved machinery for the manufacture of steel rails and also for turning out modern weapons of war. They are preparing to manufacture magazine rifles, rapid-fire Hotchkiss guns, Maxim guns and light ordnance of various kinds. The iron ore is found about 80 miles down the Yangtze, where there is also abundance of coal. A line of railway has been built and is already in operation from the mines to the river, about 17 miles in length, as noted in our last issue. The Chinese are skillful mechanicians and at the Nanking Arsenal, where no foreigner has ever been engaged, they are producing firearms of European pattern, equal it is said to those manufactured abroad.

A nickel steel gun is now being built by the Ordnance Bureau of the U. S. Navy from the designs of Mr. William Sellers, of Philadelphia. Commodore Folger, in his report, only describes it as being very simple in construction, being made of only three separate pieces. The tube can be replaced when worn by use.

### TRAINSHED AT NEW ORLEANS, LA.; ILLINOIS CENTRAL R. R.

The new steel trainshed for the Illinois Central R. R. terminal station at New Orleans, La., which was noted in our issue of May 5, 1892, has been completed, and the accompanying cut represents an interior view from the headhouse end, before the roofing was put on. The structure is about 500 ft. long and 144 ft. wide. Its width is made up of a central span of 40 ft., with two side spans of 35 ft., from the outer edge of each of which extend cantilevers 17 ft. long. The central trusses are arched, while the side trusses have inclined top chords and arched lower chords. The trusses are spaced 24 ft. apart longitudinally and are connected by trusses over the columns, having longitudinal top chords and arched bottom chords. There is a clearstory over each of the three rows of trusses. The trusses support Z-bar purlins to which the corrugated iron roofing is attached, and which are braced by vertical diagonals from the lower chords and horizontal diagonals from the top chords of the trusses. The trainshed covers nine tracks, and the end of each track is fitted with the Ellis bumping post, made by the Mechanical Mfg. Co., of Chicago, and illustrated in our issue of Oct. 6, 1892. The transverse platform between the tracks and headhouse has a lean-to roof. The trainshed was designed by Mr. J. F. Wallace, Chief Engineer of the Illinois Central R. R., and was built by the Kenwood Bridge Co., of Chicago, Ill.




NEW TRAINSHED AT NEW ORLEANS, LA.; ILLINOIS CENTRAL R. R.

### THE REPORT OF THE CHIEF OF ENGINEERS, UNITED STATES ARMY.

The last report of Gen. Thos. L. Casey, Chief of Engineers, U. S. A., is dated Sept. 30, 1892, and is for the year ending June 30, 1892. Of the 117 officers holding commissions in the Corps of Engineers, 33 are engaged on river and harbor work, 30 on fortifications and river and harbor work, 14 are with the Batallion of Engineers and at the U. S. Engineer School and 20 are on detached service. The remaining 17 officers are widely scattered in the performance of special duties.

Under the head of fortifications General Casey says that for the first time in 15 years construction has been resumed, as the act of Aug. 18, 1890, appropriated $1,221,000 for this purpose and $750,000 more was added in February, 1891. These two appropriations have been allotted to the construction of emplacements for modern rifled guns and mortars in the forts at Boston, New York, Washington, Hampton Roads and San Francisco. As showing the extent of the proposed works, it may be mentioned that the present project for the defense of the Southern and Eastern entrances to New York harbor contemplates an armament of nineteen 12-in. guns on lifts; seventeen 10-in. and nine 8-in. guns on disappearing carriages; one hundred and seventy-six 12-in. mortars and submarine mines operated from five mining casements. The estimated cost of a two-gun battery with lifts is $457,000, not including the cost of the armament; of this amount $174,000 is for the mechanism alone.

The Battalion of Engineers and the Engineer School, at Willet's Point, New York, is reported upon as follows: While the legal strength of the Battalion is five companies of 150 men each, officered by the Engineer Corps, the present strength is 18 officers and 437 enlisted men. These men are employed in engineer, pontoon and torpedo drill, in infantry drill, rifle practice and photography. In the U. S. Engineer School, during the year, 20 officers of the army outside of the Engineer Corps have completed their course in planting and operating torpedos, etc.

The remainder of this report of 450 8vo pages is devoted to the detail of river and harbor improvements throughout the United States. Under the head of bridging navigable streams, 66 bridge sites are under discussion, and 11 more bridges are passed upon as obstructing navigation.

### THE DESIGN AND CONSTRUCTION OF ENGLISH TRACTION ENGINES.*

By W. Fletcher.

There is probably no type of engine that is calculated to give more trouble and anxiety to both designer and builder than the traction engine; in fact, it has been said: "Anyone can make a steam engine, but only an engineer of special experience can build a successful traction engine." Many years of experience do not always furnish the requisite qualification, for some firms which have been longest in the trade are now anywhere but in the front rank, and the longer they live the less they appear to realize what will do, and what will not do for modern road engines. On the other hand, some of the firms, which have more recently embarked in this trade, have already made their mark, and their productions give the impression of being of the right stamp. It is well known that the proportions and strengths of traction engines can only be arrived at by actual test, but failing that, mechanical instinct and good common sense have often produced good results. It is impossible to calculate the strains to which the shafts and other details will be subjected.

At the outset, it may be well to enumerate some of the physical and mechanical difficulties that ordinary road locomotives have to surmount, after which little surprise will be felt, that many a firm's first traction engine has proved to be a dead failure. The engines must be suitably equipped for the complex duties they have to perform, and as far as possible work in harmony with the legislative restrictions under which they are placed. They must be able to traverse all kinds of roads, some of which are coated with loose metal, others are paved with smooth and slippery materials, while still others are so rotten that the wheels sink through the thin crust into the ground beneath. Soft land has often to be traversed, or the engines have to draw a threshing machine and place it in position for work in stack yards that are little better than swamps. The engines must be able to draw their loads up grades ranging as high as 1 in 10 (10%) in all kinds of weather, and must be constructed so that they will pass through narrow gateways, and turn the most acute angles without disconnecting the load. During wet weather the narrow lanes are so soft that there is a strong probability of seeing the engine gently slide into a country ditch, or suddenly sink into a bog, the rest of a rainy day being often spent by the men in charge in endeavoring to extricate the engine by the aid of planks, screw-jacks, hurdles, and anything available. All the parts must be strong enough to bear the enormous strain of such an emergency as the engine lifting itself out of this hole or ditch, so that an ample margin of strength is absolutely necessary. On the other hand, the engine must be so built that little damage is caused to the wheels, machinery, etc., by the constant jarring and jolting on hard and rocky roads and that little damage will be done to the road. Very often the engines are subjected to the roughest treatment at the hands of negligent drivers, and in some districts nothing but the muddiest water can be procured for the boilers. The lubrication is lavished without stint on the accessible parts, and fearfully neglected on important parts which happen to be less easily accessible. But amid these adverse circumstances traction engines rarely give trouble. These considerations speak volumes in favor of modern road locomotives, as touching their simplicity of construction, and non-likelihood of derangement, and the general suitability of the design for the multitudinous purposes to which they are now applied.

In addition to the mechanical difficulties there are unfortunately many annoying and unreasonable legal restrictions which are often enforced, to the owner's cost. In England there are numbers of individuals who are opposed to any but horse power being employed on common roads, and are backed up in some cases, in their crusade against traction engines, by magistrates who entertain similar views, and these dignitaries are invested with the power to place almost insuperable impediments in the way of this important industry.

According to law the engine must not run at more than four miles an hour in the open country and two miles an hour when passing through villages and towns, and in each case a man with a red flag, or a band on his arm, must walk some yards in front, to show what an evil thing is crawling behind him. The locomotive must consume its own smoke, and allow no steam to escape from the safety valves. In many districts traction engines are prohibited from crossing the bridges, although they may be sufficiently strong to bear their weight. According to the Act, this anomaly exists at the present time, "if we send a boiler weighing 15 tons drawn by 15 horses over a country bridge, and that boiler breaks the bridge we have nothing to pay, but if we send the same boiler over the bridge drawn by an engine weighing 8 tons, and that boiler breaks through the bridge, we have the whole expenses to pay." Certain urban authorities may make by-laws regulating the use of traction engines on the highways, and in many instances road locomotives are only allowed to travel during the night. It is impossible to over-estimate the increased difficulties, dangers, and the excessive cost of working traction engines in the night. Many accidents have occurred owing to shortness of water, and lack of superintendence, while the men have been struggling against great odds and groping about with lanterns. Some of these accidents have ended fatally, and are clearly chargeable to the one-sided by-laws enforced by our

* Mr. Fletcher's first paper, on "The Use of Traction Engines in England," was published, together with an editorial on "The Use of Traction Engines," in our issue of Oct. 27; and an article on "Traction Eng'n's and Steam Rollers," in our issue of Nov. 10.

local authorities. Many foolish objections are urged against the use of these engines, one of which is, that spirited horses are frightened at their approach: such horses, however, should not be allowed on the roads until they are trained, for they are just as likely to shy at a wheelbarrow as an engine, and in either case disastrous results may occur.

The above are by no means all of the iniquitous laws; but it is time to turn to the design and construction of the locomotives. All the best road engines are marked by a great similarity of general design. The arrangement of the parts is carefully considered, with a view to secure a good mechanical design and a symmetrical and neat appearance. Not only have the engines as a whole been neatly and compactly arranged, but the details in many instances are models of simplicity. It may be remarked that all attempts at so-called ornamentation, in the form of architectural mimicry so common a few years ago, have been abandoned, and in their place there is the true beauty of design, consisting of correct principles and graceful proportions worked out in the simplest and most pleasing manner, with due regard to their purpose.

The improvement in the design of these engines has been very marked during the last few years. It is not long since a paper spoke of traction engines as being ugly, noisy and in very deed a nuisance: "We have an engine without springs, and with all the gearing exposed to the glare of day, thumping, and clanking, and grinding, and smoking along our highways. The thing is a nuisance and it is folly to deny the fact." It is to be feared, however, that there are some engines made in England now, which answer to the above description.

It has already been mentioned that the general arrangement of the engines made by the leading makers present a similarity of appearance. This arises from the fact that all the traction engine builders have adopted the locomotive multitubular type of boiler, and by general consent the horizontal cylinder is placed near the smokebox end of the boiler, while the shafts and gearing are disposed for supporting the bearings of the shafts and axle. Solid foundation and firehole rings are used instead of Z-iron for the water space around the firebox.

| | | | |
|---|---|---|---|
| Nominal HP. | 6 HP. | 7 HP. | 8 HP. |
| Cylinder, diam. | 8 ins. | 8½ ins. | 9 ins. |
| " stroke | 10 " | 12 " | 12 " |
| Boiler pressure | 140 lbs. | 140 lbs. | 140 lbs. |
| Actual HP. on brake | 30 HP. | 35 HP. | 40 HP. |
| Revs. of engine, threshing | 180 | 166 | 160 |
| Revs. of engine on the road (approximate) | 300 | 280 | 250 |
| Piston rod, diam. | 1¼ ins. | 1⅜ ins. | 1½ ins. |
| Piston, width | 2¾ " | 3 " | 3 " |
| Fly wheel, diam. | 4 ft. 3 ins. | 4 ft. 6 ins. | 4 ft. 6 ins. |
| " , width on face | 6 " | 6 " | 6 " |
| Crankshaft, diam. | 3½ " | 3¾ " | 3⅞ " |
| Crank pin, " | 2¾ " | 3⅛ " | 3⅜ " |
| Countershaft, " | 3½ " | 3¾ " | 3⅞ " |
| Main axle, " | 4¾ " | 5 " | 5 " |
| Driving wheels, diam. | 5 ft. 6 ins. | 5 ft. 9 ins. | 6 ft. 0 ins. |
| Do., width of face | 4 " | 4 " | 4 " |
| Leading wheels, diam. | 3 ft. 6 ins. | 3 ft. 9 ins. | 3 ft. 9 ins. |
| Do., width of face | 9 " | 9 " | 10 " |
| First motion, pitch of gearing | 1¾ " | 1¾ " | 2 " |
| Do., width of teeth | 2 " | 2¼ " | 2¼ " |
| Second motion, pitch of gearing | 2 " | 2 " | 2¼ " |
| Do., width of teeth | 2½ " | 2½ " | 2½ " |
| Third motion, pitch of gearing | 2¼ " | 2¼ " | 2½ " |
| Do., width of teeth | 3½ " | 3½ " | 4 " |
| Slow gearing ratio | 24 to 1 | 25 to 1 | 26 to 1 |
| Fast gearing ratio | 14 to 1 | 15 to 1 | 17 to 1 |
| Height to top of flywhl. | 8 ft. 6 ins. | 8 ft. 9 ins. | 9 ft. 0 ins. |
| Total length of engine | 17 " 0 " | 17 " 0 " | 17 " 6 " |
| Total width " | 6 " 6 " | 6 " 8 " | 6 " 8 " |
| Wt. of engine empty | 8 tons | 9 tons | 10 tons |
| " " w'king trim. | 9 " | 10¼ " | 11½ " |
| Wt. on driving wheels | 6½ " | 7¾ " | 8¾ " |
| Capacity of coal b'nker | 448 lbs. | 560 lbs. | 616 lbs. |
| " " tank, U. S. galls. | 138 " | 150 " | 168 " |
| Heating surface (boiler) | 120 sq. ft. | 140 sq. ft. | 160 sq. ft. |
| Grate area | 4.5 " " | 5 0 " " | 5.5 " " |
| Boiler barrel, diam. | 2 ft. 4½ ins. | 2 ft. 6½ ins. | 2 ft. 6½ ins. |
| Smokebox, diam. | 2 ft. 8 ins. | 2 ft. 10 ins. | 2 ft. 10 ins. |
| Boiler barrel, length | 5 " 6 " | 5 " 6 " | 6 " 0 " |
| Total length of boiler | 10 " 0 " | 10 " 0 " | 10 " 6 " |
| Smokestack, diam. | 8½ " | 9 " | 9 " |
| Traveling speed, slow gear, miles | 1½ to 3 | 1½ to 2½ | 1½ to 2½ |
| Do., fast gear, miles | 3 to 5 | 2½ to 4 | 2½ to 4 |

The full quantity of mudholes and other provisions for washing out the boiler must be arranged in convenient positions. After completion the boiler is subjected to a water test up to 250 lbs. pressure per sq. inch. A sliding firedoor, two water gage glasses, and a smokebox door that will tighten equally all around the outer edge should be furnished. It is usual to allow 20 sq. ft. of heating surface and 0.75 sq. ft. of grate area per nominal horse power.

The cylinder should be steam jacketed and well drained. It is usual to combine the cylinder casing, valve chest, and stop valve chamber in one casting, made of cold blast iron. The working barrel or liner is cast separately, of special hardness, and afterwards tightly forced into the outer casing, thus forming an efficient steam jacketed cylinder. The jacket space and stop valve chamber are made of large capacity to constitute a dome, or reservoir for the dry steam. The inlet into the jacket must be arranged as near to the smokebox tube plate as possible, for experience has shown that the engines are less likely to prime when the steam is taken from this part of the boiler. In order to present an ample bearing on the boiler barrel, the cylinder should be provided with a broad base, and a flange for foundation bolts all around. The stop valve occupies the highest position in the cylinder, the opening is either V shaped, or round, so as to open gradually. The passages and steam ports should be of full area, to prevent any throttling. A double spring weighted safety valve is mounted on the top cover of the cylinder. Two displacement lubricators are fixed on the cylinder, one lubricates the side valve, and the other supplies oil to the working barrel, to prevent the piston from scoring, which it is sure to do when muddy feed water is used. For single cylinder traction engines, it is usual to allow 10 circular inches of piston area per nominal horse power.

Stephenson's link motion reversing gear is the one most frequently used, other types have at various times been introduced, but the original valve gear when carefully designed gives universal satisfaction. The slip of the die may be reduced to the smallest amount, and the parts can be so arranged that an equal cut-off and release may be obtained at both ends of the cylinder, whether working in full gear, or notched up. The engine should exert the same power in forward or backward gear, and the cut-off should be as sharp as possible.

There are very few traction engines now made having cast iron crankshaft carriages, wrought iron or steel plate box-brackets having taken their places. Even when cast iron crankshaft brackets were used, the sides of the outer firebox were generally carried backward for supporting the main axle, and occasionally for bearing the countershaft also. But it was reserved for Mr. Aveling, of Rochester, in 1870, to carry these side plates upward as well as backward, so that all the shafts could be inserted in machined holes in the plates, making a most substantial job. This system of construction was followed by most of the makers on the expiration of Mr. Aveling's patent. By referring to Fig. 1 it will be seen that the side plates are carried above the crown of the boiler and holes are bored in them to receive the crankshaft, countershaft and main axle bearings. It may be stated here that traction engine makers are somewhat divided in opinion respecting the employment of one or two countershafts. Where two intermediate shafts are used some of the gearing can be placed inside the box brackets between the bearings. When one countershaft is adopted all the gearing is placed outside the bearings. In Fig. 1 holes for two countershafts are shown in the side plates and it will be noticed also, that two plates, back and front, are inserted between the side plates and riveted to them by means of angle irons, these tranverse stiffening plates being also attached to the shell of the boiler. A wedge-shaped strip of iron is inserted between the side plate and the arch plate at A, Fig. 1, to facilitate the calking of this portion of the boiler. The longitudinal double seam of rivets passes through this wedge plate, and forms a satisfactory piece of workmanship.

The gearing plays a very important part in the construction of traction engines, but so many improvements have recently been made in the arrangement of the gearing, and in the quality of the steel of which it is cast, that little or no fear re-

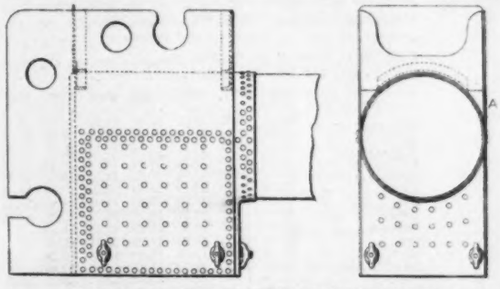



FIG. 1. EXTENDED SIDE PLATES OF FIREBOX FOR TRACTION ENGINES.

in a type of box bracket at the firebox end of the boiler. The accompanying table gives the principal dimensions of the three sizes of traction engines for general purposes.

The boiler is of the flush top locomotive multitubular type, with the shell made of steel plates and the firebox of Lowmoor iron or mild steel. It is particularly necessary that the boiler should be of the strongest form and construction, and well stayed for working safety and continuously at 140 lbs. steam pressure. A margin of strength must also be allowed to resist the strains arising from some of the engine parts being bolted down to it. In order to secure a narrow engine, which is always desirable, the boiler must be made somewhat small in diameter, and some difficulty will be experienced in providing in such a limited space, 1, a proportionate amount of heating surface and grate area, so as to acquire rapid steam making; and, 2, an abundance of steam room necessary to prevent priming. Unless the above important attributes are secured, it is impossible to have an efficient boiler.

The flanging and riveting of the boiler are done by hydraulic pressure, the longitudinal seams are double riveted, and the thick side plates of the firebox shell are carried upward, and backward

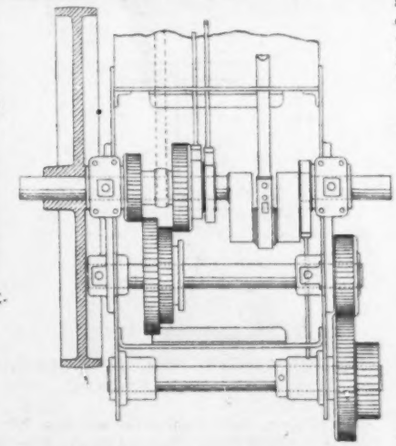


Fig. 2.

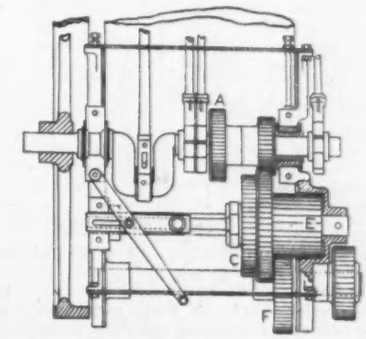



Fig. 3.

PLANS OF GEARING FOR TRACTION ENGINES.

specting the failure is entertained, and a breakdown in steel gearing is a rare occurrence. Many of the modern road engines are fitted with two countershafts, in which case the fast and slow speed wheels and pinions can be placed inside the box brackets. There is then no overhanging gearing on the crankshaft, and the remaining wheels outside are placed as close to the bearing as possible. It is urged that the inside gearing wears more evenly, and the wheels are more rigidly maintained in truth; another advantage is, that the sizes of the pinions and wheels can be regulated to the exact requirements. One defect of all the outside gear engines, save Messrs. Burrell's, consists in causing the slow speed pinion to slide inside the fast gear pinion, for the purpose of keeping them as near the bearing as possible, but this plan causes too much difference between the fast and slow traveling speeds, whereas, in the inside gearing this defect is remedied. Engines having inside gearing make much less noise on the road than those with outside gearing. Fig. 2 shows in plan a neat arrangement of gearing within the box brackets. The two pinions are keyed to the countershaft, and the two wheels slide on fixed keys

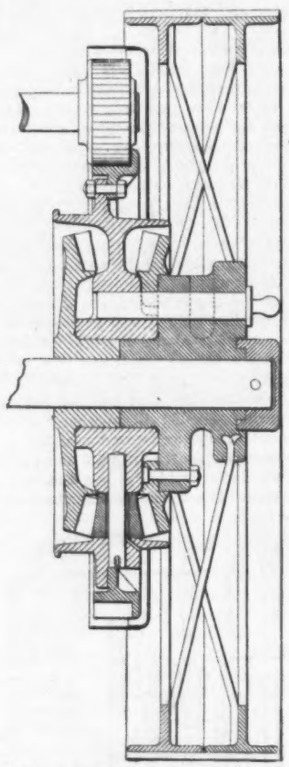


FIG. 4. COMPENSATING GEAR FOR TRACTION ENGINES.

on the countershaft. A lever, not shown, will place the wheels in any of the three positions for fast speed, out of gear, or slow speed. The wheels are now shown out of gear in the cut. The crankshaft bearings and first countershaft bearings are combined in one casting, the remaining details are snugly placed in this box bracket and explain themselves.

Fig. 3 represents another arrangement of gearing placed inside the box bracket. The two pinions are keyed to the crankshaft, the intermediate shaft is fixed, and the double speed wheel and long pinion slide on it. In the position shown in the engraving, the engine is in slow gear. By means of the lever shown the wheels and long pinion can be slid to the left so as to make the wheel C gear into the pinion A, and thus obtain a faster motion, the pinion E, being of such a length that it remains in gear with the wheel F.

In order to add to the efficiency of the modern road locomotive they are in all cases fitted with differential gearing, which is mostly placed on the main axle. This device enables an engine to turn the sharpest curves without straining the axle or wheels. It increases the steerage power, prevents damage to the roads in turning, and the wear of the cross strips on the driving wheels is greatly diminished. Fig. 4 shows an approved form of compensating gear, which consists of two bevel wheels one of which is secured to the right hand road wheel, the other is keyed to the axle and in effect keyed to the left hand wheel. These bevel wheels are driven by two bevel pinions carried on studs fixed in the compensating plate. The spur ring of the road gear is riveted or bolted to this plate. When the engine travels in a straight line the teeth of pinions act as drivers, the pinions do not revolve on their sides, but drive both the bevel wheels at the same speed. When the engine is required to turn to the right or left hand, one driving wheel having a tendency to travel faster than the other the bevel pinions revolve on their studs to allow for this accelerated speed of one driving wheel. In this instance the brake drum is cast with the compensating plate as shown in the illustration. It is sometimes necessary to render the differential gearing inoperative and this can readily be done by inserting the pin shown in one bevel wheel and the

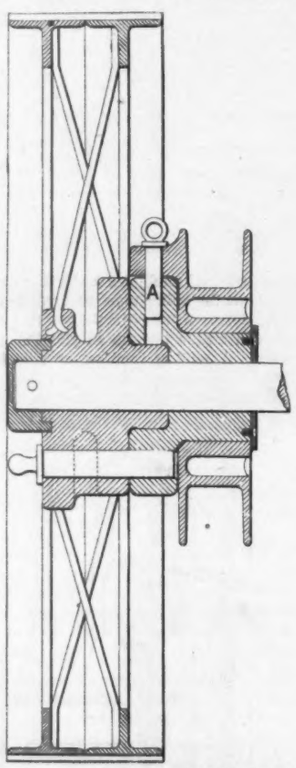



FIG. 5. WINDING DRUM ARRANGEMENT FOR TRACTION ENGINES.

central plate which carries the pinions. When the pin is inserted the gearing is locked. The winding drum and compensating gear may be neatly combined.

The winding drum is generally placed on the left-hand side of the main axle. Fig. 5 shows the latest type of winding drum, which can be disconnected from the driving disk on which it revolves, for the purpose of paying out the steel wire rope as the engine travels forward. This effects a clear saving of time. With this form of loose drum the rope is secured to the wagon or threshing machine at the bottom of the incline, the engine travels forward to the top of the hill, the rope being payed out meanwhile. When it is necessary to commence winding the driving pin is withdrawn, the small pin A is inserted in its place, and the wagon can then be pulled up the hill, and connected to the drawbar of the engine for the purpose of being hauled in the usual manner. Before a fixed winding drum could be used, the rope had to be drawn out by hand, which was unsatisfactory when compared with the improved plan.

All the handles for starting, stopping and reversing the engine, for opening and closing the cylinder cocks, for starting the pump, for opening the sliding firedoor, for applying the brake, for testing the height of the water in the boiler, and for steering, are placed as handily as possible, so that one man may drive and steer the engine if required for short intervals. There are several other details worthy of notice, and two important questions are now occupying considerable attention in England: First, the use of the compound system; and, second, the mounting of traction engines on springs.

## ECONOMY IN FREIGHT CAR LUBRICATION.

At the last meeting of the Western Railway Club a paper was read by J. N. Barr, Supt. of Motive Power of the Chicago, Milwaukee & St. Paul Ry., detailing the experience of the past eight years on that system in freight car lubrication. Mr. Barr prefaced his paper by the statement that at the present time, careful supervision, inspection and discipline of the operating force is what is most needed to secure greater economy and efficiency in railway service. He classed the duties of the supervising force under three heads: Supervision of the quality and design of the rolling stock and machinery; supervision of the quality of materials and supplies, and supervision of the use of machines and materials in service. The latter is the department of the superintendent's work which is most neglected. We reprint the substance of Mr. Barr's paper as follows:

The Chicago, Milwaukee & St. Paul Ry. Co. has used since 1884 and up to the present time but one kind of oil for freight cars. The cost of oiling freight cars during 1885 was 27.76 cts. per 1,000 miles. These figures seemed excessive, and attracted much attention. It was determined then, after considerable investigation at various points, that wastefulness on the part of the men was largely responsible for the unsatisfactory results obtained. In order to exercise a close supervision over the consumption of oil, a record was kept of the amount of oil consumed at each oiling station. With this information, it was a simple matter to check up the oil consumption, to compare stations handling approximately equal numbers of cars, and to determine with reasonable certainty the points at which a tendency to extravagance existed. At the same time considerable personal work was done directly on the

TABLE I.—Cost of Oil Used on Freight Cars on C., M. & St. P. Ry., per 1,000 Miles Run.

| | 1886. | 1887. | 1888. | 1889. | 1890. | 1891. | 1892. |
|---|---|---|---|---|---|---|---|
| Jan | 18.82 | 15.06 | 12.94 | 14.92 | 11.93 | 11.89 | 13.79 |
| Feb | 17.41 | 13.40 | 12.23 | 14.19 | 13 70 | 11.08 | 14.31 |
| Mar | 14.58 | 11.96 | 12.38 | 12.86 | 11.75 | 11.61 | 12.34 |
| Apr | 16.45 | 15.15 | 14.52 | 14.39 | 12.97 | 13.89 | 15.25 |
| May | 20.01 | 18.10 | 15.08 | 14.07 | 11.74 | 16.55 | 15.46 |
| June | 23.10 | 19.78 | 16.24 | 15.30 | 13.93 | 17.46 | 15.21 |
| July | 23.23 | 18.65 | 15.59 | 17 56 | 14.52 | 14.68 | 15.13 |
| Aug | 22.84 | 17.88 | 15.97 | 16.17 | 14.01 | 9.27 | 16.61 |
| Sept | 20.66 | 15.19 | 14.35 | 16.36 | 13.88 | 18.58 | |
| Oct | 18.76 | 11.32 | 13.98 | 13.82 | 15.63 | 17.01 | |
| Nov | 17.49 | 13.22 | 14.51 | 12.60 | 15.43 | 13.73 | |
| Dec | 15.06 | 12.84 | 14.02 | 11 80 | 15.43 | 12.35 | |
| Year | 19.09 | 14.90 | 14.35 | 14.38 | 13.49 | 15 18 | |
| Mileage (=1,000,000) | 236 | 251 | 261 | 251 | 261 | 305 | |

(Year 1885, cost per thousand miles—27.76 cents.)

TABLE II.—Hot Boxes under Freight Cars on C., M. & St. P. Ry, Requiring Removal or Replacing of Bearing.

| | 1886. | 1887. | 1888. | 1889. | 1890. | 1891. | 1892. |
|---|---|---|---|---|---|---|---|
| Jan | 231 | 229 | 289 | 215 | 220 | 460 | 625 |
| Feb | 317 | 164 | 243 | 183 | 182 | 403 | 481 |
| Mar | 420 | 435 | 431 | 280 | 257 | 493 | 719 |
| Apr | 877 | 704 | 602 | 368 | 425 | 754 | 610 |
| May | 1,008 | 1,658 | 626 | 382 | 413 | 8 1 | 683 |
| June | 1,648 | 1,147 | 742 | 382 | 587 | 1,082 | 673 |
| July | 1,545 | 930 | 732 | 523 | 758 | 1,153 | 946 |
| Aug | 1,422 | 815 | 578 | 509 | 738 | 1,554 | 856 |
| Sept | 1,564 | 817 | 783 | 772 | 790 | 1,806 | 712 |
| Oct | 1,788 | 827 | 715 | 700 | 907 | 1,313 | |
| Nov | 932 | 679 | 457 | 650 | 926 | 1,047 | |
| Dec | 450 | 711 | 270 | 320 | 776 | 754 | |
| Total | 11,711 | 8,566 | 6,448 | 5,284 | 7,078 | 11,630 | |

ground at the various stations, and one foreman who would not, or could not bring the oil consumption at this station to a reasonable figure, was removed from service.

In looking over the statement it was observed that at several minor, intermediate points on various div's ions men were employed who, in the aggregate, used quite a large quantity of oil. These men were removed and placed where their services were of more use to the company, and the latter had in addition the benefit of stopping these sources of oil leakage.

The results obtained from the above course is shown in Table I., which gives the cost per 1,000 miles from Jan. 1, 1885, to Sept. 1, 1892. The total saving in 1891 as compared with 1885 is something over $38,000, a

result obtained without changing oil, with the removal of but one man, and with very slight expenditure of money in the way of supervision and clerical labor.

It might well be asked whether in affecting this economy, some other branch of the service, as for example, the prompt movement of the trains was not unfavorably effected. In order to check this point, a record of hot boxes was established in 1886, and the results obtained from this record are given in Table II. This shows that up to April, 1890, the number of hot boxes decreased, but from that time up to April 1892, there was a large and abnormal increase in their number, making 1891 show as badly with reference to hot boxes as 1886, but not showing a corresponding increase in the cost of oil per 1,000 miles, although the increase was decided, and compared with the years immediately preceding, amounted to at least $5,000, a sum sufficient to pay for the services of a very good man, if such services would have detected and prevented the increase.

The increase in hot boxes became quite an annoyance in the movement of trains. Division superintendents claimed that the oilers were stinting too much in the the use of oil, and the usual questions as to poor oil came up. A meeting of the master mechanic and master car builders of the road was held, and a day was spent in one of the principal yards inspecting oil boxes. The result showed that in a number of cases the packing was insufficient to bring the oil properly in contact with the journal, and in many instances the waste was permeated by a mixture of dirt and sand. The waste was frequently found in almost a pulpy condition in the front of the box. In order to gain further information on these points, the following circular was addressed to all foremen of car repairers:

Circular Letter No. 115.

Sept. 8th, 1891.

Dear Sir: Hot boxes under freight cars are increasing. In order to prevent this trouble, the foreman inspector at each inspecting point will be required to personally inspect incoming trains as they arrive, with the object of noting any boxes which are beginning to warm up. They will remove the lid, inspect the box carefully, and determine whether the warming arises from lack of oil, lack of packing, bad fit of brass, grit in the packing or from whatever cause the same may be due, and make a careful report on form 154, sending it direct to this office each day. Foremen will be held responsible for any cases of the above kind leaving their station, which may be reported from the following station. This applies to time which the foremen are regularly on duty. This special report is not desired for the ordinary cases of hot boxes which have become so hot as to dry out the oil or set the packing on fire; it is only intended to cover cases in which the journals are beginning to run warm, and in which the original condition of the packing, oiling, etc., has not been changed by the heat. I feel that nine-tenths of our trouble from hot boxes arises from allowing cars to leave a station with insufficient packing; packing not properly saturated, or with a collection of grit in the box. It certainly does not arise from lack of oil as well, as we are using more proportionately now than we have been using for years.

Foremen should call the attention of their men to these cases so that they fully understand and can see for themselves the importance of properly maintaining the condition of the boxes. I am satisfied that considerable of our trouble arises from not having the waste properly saturated that is used for packing boxes. In my opinion the waste should be soaked in the oil for at least three days before being used.

Yours truly, J. N. Barr, Supt. Motive Power.

A digest of these reports received in response to this circular showed that the state of affairs as detailed above was general over the entire road, many boxes containing waste which had undoubtedly been placed there at least ten years before.

Instructions were then given to remove all waste from boxes of cars coming on the repair tracks, to reject all waste filled with sand, or worn out, to apply perfect dust guards, to mix sufficient new and well saturated waste with the old waste, to repack the box and to stencil the date of such repacking on the truck side. This operation was to be repeated every six months, or as soon thereafter as the cars should reach the repair tracks.

This practice was established in September, 1891. The improvement was not definite until April, 1892, when the number of hot boxes showed a decided improvement as compared with the previous year, but still compared unfavorably with the years 1889 and '90, is shown in Table II. September, 1892, however, makes a very favorable showing, having a less number of hot boxes than any preceding September during the term of the record. By referring to Table I. it will be seen that in the consumption of oil a definite improvement has also been made, so it is evident that the reduction in the number of hot boxes was not effected by increasing the amount of oil consumed.

In treating this subject the writer has studiously refrained from saying one word on the quality of the oil, the kind of waste used, the form and quality of the bearings, all of which are undoubtedly important, and a discussion of the same would be interesting. But the work recounted above as confined to the matter of getting improved results from what was on hand, by maintaining the boxes in good condition, and also by using judgment and care in applying the oil.

In this connection the question naturally arises whether it would not be possible to effect a further and much greater economy in the consumption of oil, the statements showing that an average cost of about 14 cts. per 1,000 miles is the best that has been obtained. The writer has no hesitation in saying that unquestionably much better results could be obtained, as he has run a passenger car for several months at a cost of about 5 cts. per 1,000 miles for lubrication. But it is also equally certain that with the present character of supervision, and the class of men employed in general as inspectors and oilers, such results are absolutely unattainable.

The writer has shown, however, that with a little care and attention an annual saving of $35,000 has been effected in the comparatively minor matter of lubricating freight cars. A very important point has also been shown, namely, that no matter how much improvement may be made in any service whatever, it is unsafe to relax vigilance with the idea that the standard of efficiency will be maintained. In no way can a given standard of efficiency be maintained, except by the constant and discriminating scrutiny of the supervising power. This scrutiny should be so complete and extended as to include not only a knowledge of the amount and cost of material consumed, and any increase or decrease in the same, but should be of such a character as to point out definitely and promptly the cause of such increase or decrease, whether due to the quality of material, the character of the men using the same, or variation in the service.

## THE FIRST CASTING MADE IN AMERICA.

The iron kettle shown in the accompanying illustration is believed to be the first casting made in America. It was recently presented to the city of Lynn by a descendant of the original owner of the land on which was located the Saugus Iron Works, where the kettle was cast in 1642. Several prominent citizens of Lynn joined in the formal presentation to the city of a case for the ancient relic, and a presentation address was made by Mr. C. J. H. Woodbury, M. Am. Soc. C. E., which we abstract as follows:

The First Casting Made in America.

The land on which the Saugus Iron Works were built was sold to the "Company of Undertakers for the Iron Works" by Thomas Hudson, who claimed in consideration the first article made at the works. This kettle was kept by him and his descendants in the male line for over a century, and then, in the fourth generation from the original owner, passed to Mary (Hudson) Lewis. She gave it to her daughter, Mary Lewis, and she in turn presented it to her nephews, Arthur and Llewellyn Lewis, from whom it has now been purchased. The authenticity of the relic has been examined and attested by several able antiquarians.

The design of the kettle is that of a type used in the earliest colonial days, but in its physical characteristics it bears evidence of being made of iron cast directly from the ore as reduced in a blast furnace, and not from pig iron melted in a reverbatory or cupola furnace; and there is no evidence or reason to believe that there was either of these furnaces at the Saugus Iron Works.

As early as 1622 an attempt was made at iron manufacture in Virginia. Works were built at Falling Creek, about 76 miles from Jamestown, to reduce bog iron ore; but they were burned by the Indians and the settlement was destroyed, some 350 persons being massacred. Thus the first successful manufacture of iron is credited to Massachusetts.

The bog iron deposits in the upper Saugus meadows were discovered by Thomas Dexter, one of the colonists of the Massachusetts Bay Company. He informed his fellow-townsman, Capt. Robert Bridges, who went to London and formed the Company of the Undertakers for the Iron Works. The enterprise was tarted under the management of these two men, with Joseph Jenks, one of the best workmen of the day, as master mechanic. Capt. Robert Bridges was one of the leading men of the settlement, having been intrusted with diplomatic offices on the part of the Colony of Massachusetts Bay. Of him it was said by Nathan M. Hawkes:

No man who lacked suavity and winning social manners could have persuaded calculating London merchants to have ventured their dearly loved funds in an iron works experiment across the Atlantic in a savage and unknown land.*

The site of the iron works was well selected, being situated at the head of navigation, by the ford in the highway from Boston to Salem, at a water-power, and near to the bog iron ore deposits, whose exact location is unknown, save that they were in Adam Hawkes' meadows. The whole iron works tract probably covered 3,000 acres.

There is not any detailed description of the works and the exact methods employed, but there is much light thrown upon these matters in the voluminous records of continual legislation and litigation, which took place during the 46 years that the works were in operation.

The works contained a blast furnace, in which bog iron ore was reduced by means of charcoal, using as a flux lime, which in the earliest days of the works was obtained from the oyster shells, which then abounded on the coast of Massachusetts Bay. Cannon were also melted at this foundry, far in advance of the time when swords were to be beaten into ploughshares, or spears into pruning-hooks.

The iron from the blast furnace was run into straight trenches in the sand, and thereby cast into long triangular bars called "sowe iron," which were converted into wrought iron and steel. Castings were made directly from the metal flowing from the blast furnace into a pool, whence it was dipped by crucibles and poured into the molds. The cupola furnace was not invented until 1790.

The manufacture of wrought iron and steel must have been entered upon contemporaneously with that of cast iron, as John Endicott, of Salem, the first Governor of Massachusetts Bay, wrote to Governor John Winthrop, at Boston, Dec. 1, 1642: "I wish to hear much of your son's iron and steel;" the son being John Winthrop, Jr., who was interested in the Saugus Iron Works.

The wrought iron and steel were made in a blomary, which may be described as a charcoal fire 4 ft. thick in a blacksmith's forge. The end of a bar of sow iron was plunged into the fire, and in time a pasty mass of wrought iron would settle to the bottom. Other portions of the bar would be converted into steel when the process stopped at the intermediary stage between cast and wrought iron. This process of steel making is still used throughout the Oriental nations, and also in the mountainous region south of the Ohio River.

The iron works also included a machine shop, in which the first fire engines made in America were built for the Town of Boston, in accordance with a vote of the town meeting, March 1, 1654, that "The select (men) have power and liberty to agree with Joseph Jynks for Ingins to convey water in case of fire, if they see cause so to do."*

Although the iron works were in operation very soon after building was commenced, yet additions were made during a number of years. In 1645, an order of the General Court shows that the works had "some tons of sowe iron cast and some in process for the forge," and letters of Governor Winthrop in August and September, 1648, state that the furnace produced seven to eight tons per week. The principal product was bar iron "as good as the Spanish," costing £20 per ton, also axes and agricultural implements.

When Governor John Endicott began the Oak Tree and Pine Tree coinage in 1652, the dies were made by Joseph Jenks at the Saugus Iron Works. It is stated by Judge James R. Newhall that the designs were made by Elizabeth, the wife of Joseph Jenks, the master mechanic. This coinage, bearing the stamp "Massachu-

* "Magazine of American History," Vol. XXV., p. 150.
* Brayley, "History Boston Fire Dept.," 1889, p. 7.

setts State" without reference to the throne, was probably the first fundamental act of independence to the mother country. The colonists were driven to such a course by the lack of money, as exchanges were for the most part carried on in barter with bullets and wampum serving for small coin.

Joseph Jenks also invented a sawmill, which received a patent for 14 years from the General Court on June 10, 1646, being the first patent granted in America. He also invented the modern American scythe, long and narrow and stiffened by a ridge along the back, a marked improvement "for the more speedie cutting of grasse" over the broad short bushwhack scythe made from a thin plate of steel; and richly deserved the patent for seven years which was granted by the General Court, May 23, 1655. In 1667 he petitioned the General Court relative to a wire manufactory; and May 15, 1672, his petition to coin money was refused.

The litigation to which the iron works were subjected increased and became oppressive.

The works are not known to have been in operation after 1688, when the tract had diminished to 900 acres and passed into individual ownership. If the supply of bog iron ore had been sufficient for the works, they would undoubtedly have been continued the same as other enterprises of that day in various parts of New England.

The immediate return to those engaged in the enterprise is now of little moment, but the results to the whole colony of an establishment which attracted, developed and then scattered a body of skilled mechanics were of great importance and no doubt may have been an essential factor in rearing many prominent industries.

## WORLD'S COLUMBIAN EXPOSITION.
### Hygiene and Sanitation.

A comprehensive exhibit illustrative of the present condition of sanitary science is to be made under the direction of the Bureau of Hygiene and Sanitation, which is a bureau of the Department of Liberal Arts. This is a subject of great and growing importance and the exhibits should be very instructive. We give herewith an abstract of a circular issued by the Bureau. Mr. F. W. Brewer is Superintendent of the Bureau of Hygiene and Sanitation, and Mr. S. H. Peabody is Chief of the Department of Liberal Arts.

Starting from the standpoint that the common health is the common wealth, and that hitherto sanitation and sanitary science have not received that amount of general public support which their importance demands, the Bureau will seek to set before the visitors to the exposition such a representation of sanitary work and sanitary aids as will help to lift the general mind to a higher plane in its estimate of the work of sanitation. Not even the most exaggerative optimist would assert that the sanitary arrangements of our chief and best-cared for cities are perfect, while it is well known that those of smaller towns and villages are of the most reprehensible type. On the other hand the pessimist cannot deny that the last two decades have seen very great and very marked improvements in the theory of hygiene as a science and in its practice as an art; the vantage ground thus gained, it is to be hoped, will be but a new base from which a more general and complete advance all along the line may be made. That eminent sanitary pioneer, Edwin Chadwick, dared to predict that the realization of municipal and domestic sanitary reforms would eventually result in the establishment of a death rate of five to seven per thousand in hygeian districts; thus every improvement of sanitary measures will be an aid to the fulfillment of Chadwick's vision. The often quoted, but never to be forgotten, results of sanitation in the city of Munich are an apt illustration of the benefits derivable. When that city was devoid of sewerage and pure water supply, the death rate from typhoid fever—pre-eminently a disease reveling in filth—was 24.20 per ten thousand. The illustrious scientist, Pettenkofer, was consulted, and recommended the establishment of a system of sewerage and the introduction of a water supply from a new source. Upon the inauguration of the new systems the death rate was reduced to 13.30 per ten thousand; partial progress further reduced it to 9.26, and the completion of the cloacinae caused the rate to finally fall to 1.75 per ten thousand, at which it has approximately remained.

While much in front of most other countries, the United States with a death rate to-day of 18 per thousand, has an arduous advance to make, but it is confidently anticipated that among the achievements of the World's Columbian Exposition that of advancing the work of sanitary reforms will not be the least. The United States has been the pioneer and is still the leader in so many departments of the world's progress that it can scarcely be too enthusiastic to hope that she may rapidly forge to the front and assert her claim to be the leader in sanitation. Nowhere on the world's face are the enormous piles of masonry so numerous as they are in America; nowhere on the world's face ought the care of public life and health to be so great.

The aim of the Bureau of Hygiene and Sanitation will be to show as adequately as possible the position in which the theory and practice of hygiene stands at the present day, and it is hoped that the universities and colleges, the boards of health, state and municipal, the societies having hygiene and sanitation as their keynotes, the scientists, the physicians, the manufacturers and the public generally, will cordially cooperate in the endeavor to make the exhibition worthy of the science and of our country. Such varied sources will naturally produce varied results. Varied results shown in diverse ways will serve to heighten the general interest in the one theme. The theme has but one end in view, the improvement of the common health. The following is the general classification of the division:

Class 285.—Gymnasium and apparatus for physical development.

Class 286.—Alimentation.—Maps and diagrams of geographical distribution of foods. Samples of pure and adulterated foods. Detection of adulterations and apparatus used in analysis. Models of abattoirs, kitchens, restaurants, canteens, etc.

Class 287.—Dwellings, Etc.—Models of buildings showing defects and unsanitary conditions. Proper modes of building, draining, ventilating and warming houses on sanitary priciples. Sanitary but economic construction of public and private buildings Models and designs of buildings of all kinds in reference to their sanitary qualities, and characterized by the conditions best adapted to health and comfort, including dwellings for workingmen and factory operatives, in connection with large manufacturing establishments; tenement houses, flats and suites of apartments, city and country residences, club houses, school houses, improved buildings for schools, court rooms, theaters, churches, etc.

Class 828.—Hotels, lodging houses, etc.

Class 829.—Public Baths and Lavatories.—Public urinals and closets. Manufacturers' exhibits of sanitary appliances and methods for dwelling houses, buildings and cities. Apparatus for heating, lighting and ventilating buildings in their relation to health. Models and designs for drains and sewers. Night soil apparatus, carts and other appliances for the removal of night soil and refuse. Disposal of sewage and refuse. Earth and ash closets. Commodes and utilization of sewage; manufacture of poudrette and other fertilizing materials. Baths, washing apparatus, detergents, etc. Refuse crematories. Non-poisonous paints and wall papers, floor coverings, decorations etc. Various modes of disposal of the dead in the past and present. Cremation and desiccation.

Models and designs of aqueducts. Plans of waterworks, artesian wells, pumping stations, modes of distribution (ancient and modern). Apparatus for cleansing mains, etc. Models and designs of reservoirs, filtering beds and associated subjects. Public drinking fountains; drinking fountains and troughs for animals. Filters and other methods of purifying water. Apparatus for chemical and biological examination of water. Diagrams, etc., of results. Analytical laboratory work. Illustrations by models and drawings of diseases produced by and conveyed through the impurities of water. Charts showing the mortality caused by diseases generally referable to impurity of water supply. Laboratory arranged for bacteriological investigation, in which will be illustrated the modes of preparation of cultivating media; modes of cultivation of germs, disinfection, etc. Diagrams and illustrations in various forms of bacteria, etc. Apparatus for the prevention of infectious diseases. Methods, materials and instruments for destroying germs. Disinfectors and disinfecting apparatus for material, houses, etc. Disinfectants and deodorants. Apparatus and fittings for warming, ventilating and lighting schools; school latrines, closets, etc. Special school fittings for storing and drying clothing. Precautions in schools for preventing the spread of infectious diseases; school sanitaria, infirmaries, etc. Hygienic clothing.

Class 830.—Hygiene of Workshops and Factories.—Models and designs of workshops and factories. Improvements in the arrangement and construction of workshops, especially those in which dangerous or unwholesome processes are conducted. Apparatus and fittings for preventing or minimizing the danger to health or life from carrying on certain trades. Protective objects for personal use; mouthpieces, spectacles, hoods, etc., for the use in certain unhealthy and poisonous trades. Ventilation of workshops: by simple discharge of internal air; by destroying offensive or injurious quality of discharged air. Removal of effluvium nuisances: by condensing and utilizing vapor; by consuming vapor; by other means. Removal of dust nuisances in certain trades. Prevention of danger from infectious diseases that may arise in wool-sorting, rag-picking, etc. Prevention of accidents in workshops, factories, mines and elsewhere. Other inventions or improvements for ameliorating the condition of life of those engaged in unhealthy occupations. Means for economizing human labor in various industrial occupations. Methods of combating diseases and deformities caused by unwholesome trades and profession; preservative measures, etc. Meteorology in connection with hygiene. Diagrams, models and apparatus illustrative of the climatal conditions prevailing in various parts of the world; the climatal relations between health and disease; rainfall, percolation and flow from the ground, etc. Illustrations and charts relative to the beneficial effect of certain climates upon certain diseases.

Class 833.—Protective Supervision.—Sanitary supervision; vaccination; isolation of infectious diseases; quarantine; prevention and elimination of animal epidemics. Models and designs of quarantine establishments; quarantine ships; disinfecting vessel, etc. Models, charts and diagrams, showing the work of the various state boards of health in the prevention of mortality and sickness from infectious preventable diseases; results of isolation and disinfection in comparison with lack of either or both. Food inspection; regulation of abattoirs, mills, etc. Building regulations and inspection. Fire regulations. Charts of fire statistics. Personal inspection: color tests, etc.; professional examination for licenses, etc. Immigration: reception, care and protection of immigrants. Control of immigration in so far as sanitation is concerned.

The Bureau will arrange as far as possible for the presentation by exhibitors of models of sanitarily built and equipped dwelling-houses, urban and rural; farmhouses; schoolhouses; public lavatories, closets and urinals; crematories for the dead; crematories for garbage, etc. If any of those subjects should be left unrepresented by exhibitors, the Bureau will endeavor to supply the deficiency.

It will also exhibit scientifically arranged laboratories for the prosecution of bacteriological research, and of hygienic analytical investigations. It will seek to supplement the valuable labors of the boards of health and of sanitary societies by codifying and collectively tabulating the results of their work. Food and food adulterations will receive special attention, and it is desired that a complete illustration of those important subjects may be obtained. The great problems of potable water supply, drainage and sewerage, ventilation and heating will all be duly cared for, and it is hoped that municipalities, companies and associations, as well as individual exhibitors engaged in those departments of sanitation, will aid in the efficacy and interest of the division by displaying models and illustrations of their work.

The state boards of health are asked to prepare charts showing the mortality statistics of their state; the morbility statistics of infectious diseases; the effect of isolation and disinfection in prevention or minimization of disease, and any other charts, diagrams, models, etc., that may be deemed desirable.

Associations and societies engaged in sanitary work of any kind are solicited to have their aims and results represented by models, illustrations, charts, etc. During the last decade much improvement has been wrought in the welfare of the denizens of our crowded cities by the labors of many philanthropic bodies, and the women of this and other countries have, as usual, been among the foremost to appreciate the value of sanitary measures and to stimulate their enforcement by the various authorities. It is anticipated that this portion of the division will not be, by any means, the least interesting and instructive.

It will be most desirable, for the convenience of hanging them without loss of much required space, that all maps, charts and diagrams exhibited by state boards of health, and associations and societies, shall all be of uniform dimensions. It is suggested that all state maps shall be drawn on the scale of four miles to the inch, excepting those states the area of which is very large; for those it will be desirable to reduce the scale, whereas for the small, but densely populated states, a more liberal scale may be chosen. The map should show the more important natural features, coasts, mountains, rivers and the railways and larger towns. The counties may be shown by shaded outlines. It is recommended that charts and diagrams be prepared of a uniform size on cardboard sheets $22 \times 28$ ins., so that they be readily inserted into frames which should measure $24 \times 30$ ins. It is further recommended that the graphic mode of representing percentages be adopted; but it would be advantageous to attach to the graphic form the actual figures of the percentages.

The Bureau desires to form a library which shall represent as fully as possible all the phases of hygiene and sanitation.

To accomplish this object, all the state boards of health, and their auxiliary local boards of health are asked to contribute copies of all their reports and other publications bound in suitable substantial binding, and lettered on the back with the name of the state (in case of an auxiliary board, with also the name of the city or district) and the date of the report. Forms, notices or circulars used in the work of the board should be bound in a separate volume. Sanitary associations and societies are asked to contribute

their reports and publications bound in a similar manner. Authors and publishers also are asked to send a copy of such works as they have published on hygiene, sanitation and cognate subjects. The books should all be lettered on the back with the title, name of author, name of publisher, date of publication and publication price.

The suggestions and invitations made are intended to be also fully applicable to other countries; therefore the commissioners representing the governments, and the representatives of sanitary science in all nations are cordially asked to accord to the division their valued cooperation.

The superintendent of the bureau of hygiene and sanitation invites from experts in any of the branches of the science any suggestions or recommendations that will aid in making the exhibit of the division complete and serviceable.

### Roofs of the Buildings.

According to the report the roofs of several of the main buildings are giving considerable trouble by leaking, and a special inspection is to be made. The leaking is said to be of such an extensive character as to warrant the statement that there is not a single roof on the buildings that is satisfactory. They all leak, and, according to reports, the reason for their leaking is that they were cheaply constructed.

Among the worst is the Mines and Mining Building, and, when several months ago its roof was finished the superintendent of the building discovered in it 240 distinct holes. The Woman's Building is another structure which has leaked continuously from the time it was built, and in the Service Building, the offices of the director of Works, and the different chiefs have been invaded by rainwater. In view of these facts the Council will make a tour of inspection. At the New Orleans Exposition the government was obliged to pay $135,000 to reimburse exhibitors whose goods were damaged through carelessness in one way and another.

In the Manufactures Building there are 32 acres under roof, and this roof leaks at an alarming rate. In the building England, France and Germany have each 125,000 sq. ft. of space. The products to be exhibited there will be of a costly character. The degree of rainfall which has hitherto found its way through the roof of the big building would cause many thousand dollars' worth of damage as well as inconvenience. The United States Government would have to pay the cost. It has invited foreign nations to exhibit, they have accepted the invitation, and the contract has thus been formed. Such at least was the case at the New Orleans Exposition. The consuls of foreign governments simply referred the instances of damage to exhibitors from their countries to their respective ministers at Washington. In consequence the President requested an appropriation by Congress to cover the losses and this was done. The necessity for protecting exhibitors from damage by rain has become apparent to the Council of Administration. It is said to be not improbable that the roofs of the Mines and Mining and the Woman's buildings will have to be replaced by new ones. Continual patch work has been the rule on these buildings ever since they were completed, and still they leak to such an extent as to menace the safety of the exhibits.

### EXPANSION JOINT: MEMPHIS BRIDGE.

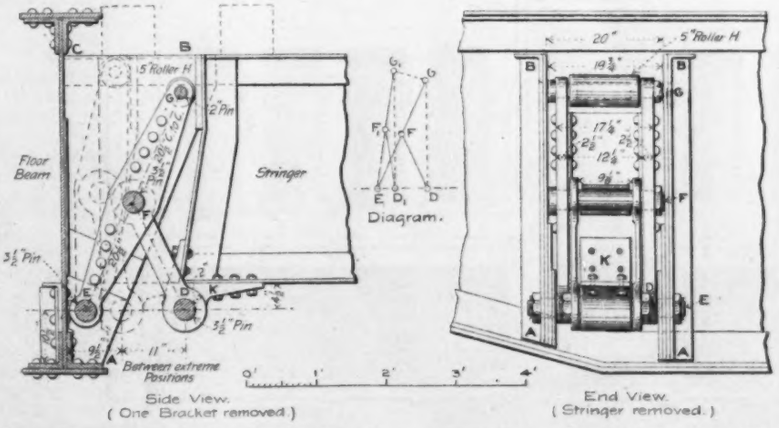
In bridges of long span, provision for expansion and contraction due to changes of temperature has to be made by means of expansion joints, and the accompanying cut represents a novel form of expansion joint used in the steel floor of the Memphis bridge. This bridge has been fully described and illustrated in our columns, (Eng. News, May 12, June 16 and Sept. 15, 1892). The joint was designed by Mr. Ralph Modjeski, bridge engineer, of Chicago, who was assistant engineer on the Memphis Bridge, under Mr. George S. Morison, Chief Engineer. The device has not been patented.

At the point of the Memphis Bridge where the 450 ft. suspended span connects with the cantilever arm, an expansion of 11 ins. occurs between the extreme temperatures. This expansion had to be provided for between the end of the stringer of the suspended span and the floor beam of the cantilever arm. It was impracticable to adopt the usual arrangement of the stringer sliding or rolling on brackets attached to the floor beam, and such an arrangement would produce considerable torsional strain in the latter. The following is a description of Mr. Modjeski's solution of the problem:

The arm E G is connected at the lower end with two brackets A B C, riveted to the floor beam, by means of a pin E. These brackets act as guides to the expansion gear and the end of the stringer. On the upper end of the arm E G is a 5-in. cast steel roller which rolls on the vertical surface of a plate riveted to the end of the stringer. In the center of this arm is a pin to which are connected two links, F D, which support the stringer by means of a pin D and a steel casting K, bolted securely to the bottom of the stringer.

The design is made to fill the following conditions: The distances from the centers of pins E D and G to the center pin F, are all equal. The three pins E, F and G have their centers on a straight line. The centers of the two pins G and D are always on the same vertical line, although the distance from E to D varies. The diagram shows the motion of the links. It results from this arrangement that point D is always on the circumference of a circle of which E G is the diameter, E F, D F and G F being equal, and therefore that the angle E D G is always 90°. As G D is vertical, E D is horizontal, and the point D travels horizontally.

The motion of the links can also be explained by the problem of elementary geometry of constructing a perpendicular at the end of a straight line. The friction of this arrangement is comparatively slight, and the torsional strain transmitted to the floor-beam is inappreciable. There is a slight increase of compression in the top flange and of tension in the bottom flange of the stringer.




EXPANSION JOINT (Designed by Ralph Modjeski, C. E.) USED IN FLOOR OF MEMPHIS BRIDGE; Geo. S. Morison, Chief Engineer.

**Landslides and washouts have occurred in Oregon and Washington, owing to heavy rains west of the Cascade Mountains, and traffic on the Northern Pacific and Union Pacific railways has been considerably interfered with.**

### EFFECT OF A FIRE ON A CHICAGO BUILDING OF FIREPROOF CONSTRUCTION.

The practical and severe fire test of the nine-story fireproof building of the Chicago Athletic Club, which building is of steel frame construction now so generally used, was noted in our issue of Nov. 10, and as was then stated, it successfully stood the test. This system of construction was fully described in our issues of Dec. 5, 12 and 26, 1891, and Jan. 2 and 9, 1892. We are indebted to Mr. E. S. Pike, Chairman of the Building Committee of the Chicago Athletic Association, for reports made upon the effects of the fire by Gen. Wm. Sooysmith and Mr. Isham Randolph, both well-known engineers. We give below the main facts of these reports, by which it will be seen that special care should be taken to securely attach the fireproof tiling, etc., to the columns and walls. The joint report just made by the engineers mentioned is as follows:

It is evident that the building when it took fire contained a very large quantity of combustible materials. There was a great deal of scaffolding and wood finishing material distributed throughout the building, particularly in the gymnasium. If the building had been completed, it would never have contained combustible material enough to have produced heat enough to have done any considerable injury to the building by burning. The heat of the fire that has occurred was evidently intense, as some of the steel beams where they were not as yet fireproofed, are badly bent by expansion where their ends were confined.

We have nowhere discovered that the metal portions of the building where the fireproofing held, have been deformed or injured. And even where the fireproofing tile dropped off, from the burning out of the nailing strips which supported them, the columns seem to have

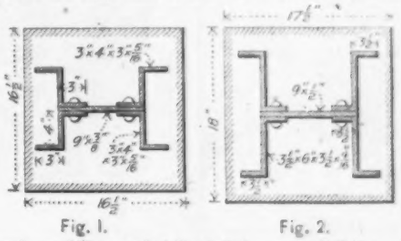



Fig. 1. Fig. 2.

Sections of Fireproofed Steel Columns in Building of Chicago Athletic Club.

supported their loads without bending, except two on the eighth floor, owing, no doubt, to the fact that the greatest heat had been expended before these strips were so burnt away as to permit the tile covering to drop off. This building furnishes an assurance that was lacking before, that the metal parts of a building, if thoroughly protected by fire roofing properly put on, will safely withstand any ordinary conflagration, if the quantity of combustible materials the building contains is not greatly in excess of that which enters into the construction of the building itself. In this instance we do not think that the fireproofing was properly bonded. We found the exterior walls and floors intact, and only the ornamental parts and the caps, sills and casings of the windows badly cracked and spalled. The integrity of the building does now seem to be impaired, and it may be made as good as new by replacing the parts injured.

Mr. Randolph also submitted the following notes made by him as the result of his examination of the building, the examination being made independently of that made by Gen. Sooysmith, but both being made at the same time:

One very self-evident result of my investigations is the fact that better methods of bonding the fireproofing materials around the columns will have to be resorted to if all the benefit of fireproofing is to be secured. No doubt exists in my mind that in the instance before us the fireproofing around the columns saved them from an utter collapse, by remaining in place until the fuel which fed the flames was well nigh exhausted; but that was a fortunate accident, and not a result assured by the method of construction. It seems like a presumption upon the possible carelessness of others to venture the suggestion that before any work of reconstruction is permitted to be done, that the debris should be entirely cleared away, so that a critical examination of every detail of the construction can be made and every part known to be safe before it is hidden by new construction.

Ninth Floor.—But little damaged. Plastering peeled off walls of northwest corner room. Elevator shaft damaged.

Eighth Floor.—Gutted east of the west 45 ft. In the front room the hollow tile fell away from the wrought iron columns and they show signs of severe punishment.

The east and west columns of the south row of three in the front room are decidedly out of vertical and the middle column badly warped. (Fig. 1 shows the section of these columns.)

Seventh Floor.—Badly wrecked, but damage confined to burning out of casements and peeling off of plastering, and destruction of a few thin partitions. I note that in the northeast corner room, next to the stairway space, where the partition between the room and the stair hatchway had fallen in, one or more cans containing gasoline were found in good condition. The men who found them removed or secreted them very promptly.

Sixth Floor.—Completely gutted of doors, windows, window casings, and plastering. The I-beam supporting the wall between the northeast corner room and the stair area is bulged westward, and the wall above in a tottering condition. I-beams over light areas badly warped and buckled.

Fifth Floor.—Gallery, or race track, around gymnasium, badly wrecked. Gymnasium, or fifth floor, gutted. The fireproofing of the columns failed completely, owing largely to the very faulty method of girding the column at intervals of about 3 ft. 4 ins. with wood, separating the successive length of fireproofing tiles by material destructible by fire. These wooden girdings charred out and let the tiles fall, leaving the column with no protection from the heat. I fail to discover any warping or other deformation of these columns. (Fig. 2 shows the section of these columns.) None of the floors show any sign of weakness other than the falling away of an occasional tile from the ceilings.

Fourth Floor.—The east front rooms on this floor escaped all damage from the fire, but are damaged by water. The rest of the floor suffered from fire; the woodwork being destroyed, but, so far as I can see, it is not impaired in point of stability. Below this floor I could see no fire damage, and whatever damage there is, I judge it due to water.

Michigan Ave. Front.—Above the gymnasium it is badly defaced, the stone used in its construction having scaled badly.

Exterior Walls.—Apart from the damage noted above to the Michigan Ave. front, the main or exterior walls seem to be in excellent condition. No displacement or bulging is evident to the unaided eye. There seems no reason for questioning the integrity and strength of the building in its entirety after such renewals of damaged material as can readily be made have been effected.

Mr. Pike considers that while a part of the fireproofing was ruined, it would not have been ruined had not the firemen thrown water on it when it was thoroughly heated, his claim being that the water was unnecessary as the fire had done all the damage possible before the water was thrown on. The fireproofing, however, should be so put on as to stand the application of water without falling off, as it is most likely to be subjected to such treatment in case of fire. But it is not fair to lay the responsibility upon the firemen, whose first aim and duty is naturally to direct water into a burning building to extinguish the fire and prevent it from spreading, without considering what incidental damage it may do.

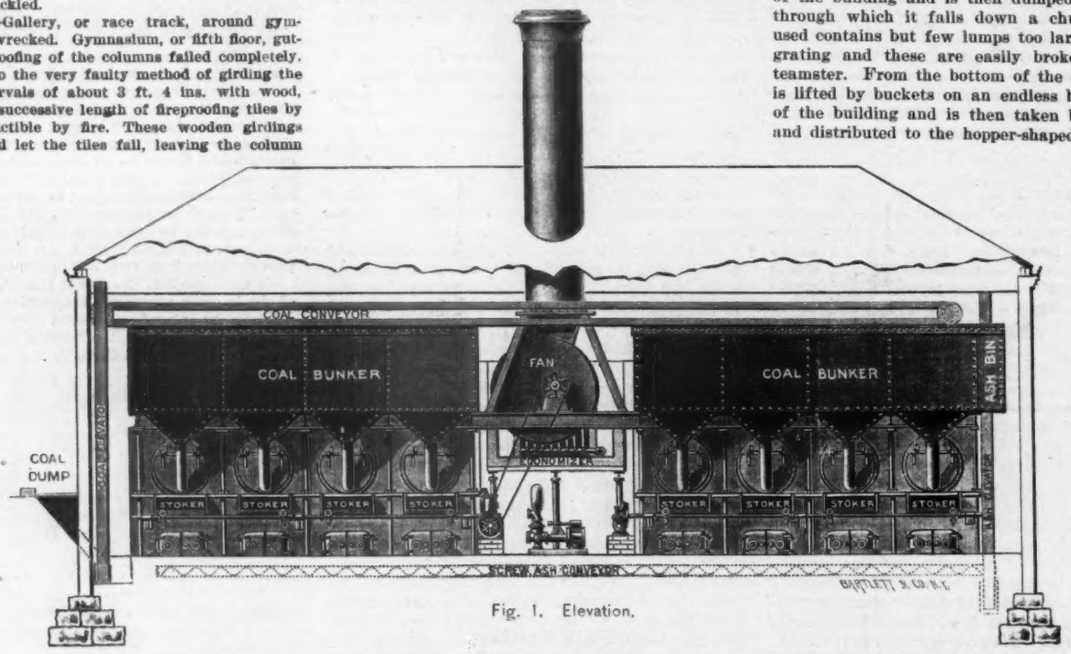



Fig. 1. Elevation.

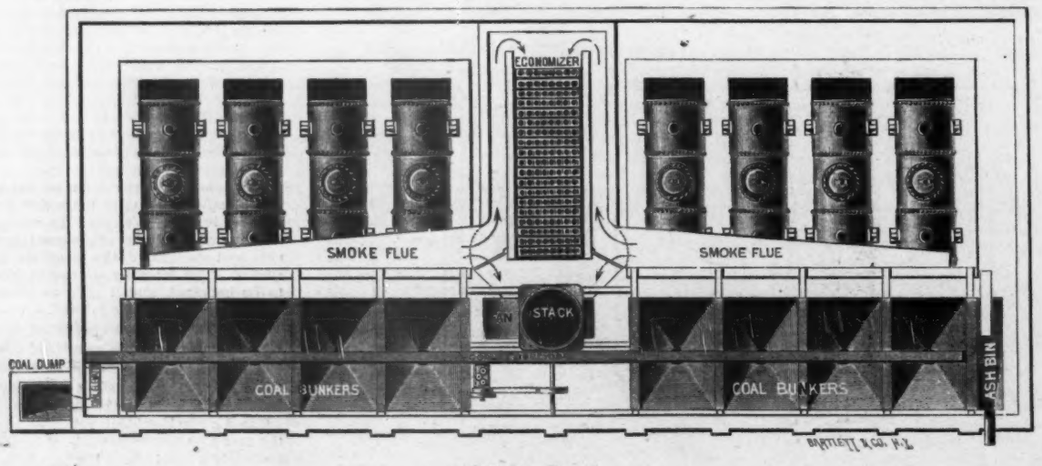



FIG. 2. Plan.

BOILER PLANT AT WORKS OF CURTIS, DAVIS & CO., ENGINEERS, CAMBRIDGEPORT, MASS.; Westinghouse, Church, Kerr & Co., Engineers.

## A FORCED DRAFT BOILER PLANT WITH AUTOMATIC STOKERS.

We illustrate herewith a boiler plant of 1,000 HP. recently completed for Messrs. Curtis, Davis & Co., of Cambridgeport, Mass., by the engineering firm of Westinghouse, Church, Kerr & Co. The features of the plant of especial interest are the use of forced draft to such an extent that the chimney is practically dispensed with, in combination with a fuel economizer by which the heat in the furnace gases is thoroughly extracted before they are discharged. The plant is equipped with Roney mechanical stokers, the general arrangement of which is shown in the accompanying drawings.

The boilers are of the horizontal return tubular type and are designed for 130 lbs. steam pressure. They are arranged in two batteries of four each, the space between the batteries serving as a pump room. Referring to the perspective view, Fig. 5, the coal, which is hauled by wagons to the plant, is weighed on a platform scale at one end of the building and is then dumped on a grating through which it falls down a chute. The coal used contains but few lumps too large to pass the grating and these are easily broken up by the teamster. From the bottom of the chute the coal is lifted by buckets on an endless belt to the top of the building and is then taken by a conveyor and distributed to the hopper-shaped bunkers, one for each boiler, extending the length of the building. The bunkers are supported on iron girders. They open at the bottom into a tubular passage leading down to the automatic stoker. This is shown in section in Fig. 3. The coal is delivered into a small hopper and is slowly and steadily moved down toward the grate, being gradually coked on the way, and the gases given off are burned over the hottest part of the fire, thus preventing the formation of smoke.

After leaving the coking arch the coal is slowly worked down over the rocking grates into the hottest portion of the fire, and when consumed the ash and cinder falling on the dumping grates is

dropped into the ashpit. From the ashpit the ashes fall into a screw conveyer, which carries them to one end of the building, where they are elevated into an ash bin and discharged as required through a spout into carts for removal.

It will be seen that from the time the coal is dumped from the wagons until the ashes pour into the cart which hauls them away, manual labor is not once concerned with the movement of the fuel, the ashes or even of the burning coal. One man attends to the whole plant. A small engine mounted on a bracket at one end of each battery furnishes the power to drive the stokers.

The forced draft is furnished by a large exhaust fan placed at the base of the stack and giving ample draft at a speed of only 40 to 50 revs. per minute. It is driven by a small Westinghouse engine (10 HP. nominal) controlled by a throttling governor which is regulated by the steam pressure in the boilers. Thus the speed of the fan and the force of the draft is automatically varied with the demand for steam upon the boilers.

A 200-ft. chimney would not give as powerful a draft as can be produced by this fan; and the forced draft is under the absolute control of the fireman, while the natural draft varies with wind and weather and with the condition of the fire. The uptake consists of a 72-in. steel stack lined with one course of brick to prevent corrosion. Its top is 17 ft. above the ridge of the roof and its base rests on an entablature which is supported on the same beams that carry the coal bunkers. The pile foundation alone which would have been required for a chimney of proper height would have cost more than the entire expense of the forced draft plant.

The forced draft system is not wasteful of fuel, as is sometimes supposed, for against the steam consumed by the engine which drives the fan must be set the thorough extraction of heat from the gases of combustion. From the boilers the gases are drawn through a Lowcock economizer or feed water heater which delivers the feed water to the boilers at the full temperature corresponding to the steam pressure and reduces the temperature of the gases in the uptake to about 100° F. The economizer is placed between the two batteries of boilers and is carried on iron columns, leaving the floor space entirely clear.

A common objection to forced draft is that any breakdown of the machinery puts the boilers out of service. Provision is made in this plant to meet this objection. A by-pass with suitable dampers permits the gases to go from the boilers directly to the stack, and a steam ejector nozzle set in the base of the stack will furnish ample draft.

A by-pass in the hot water feed pipe permits the feed water to be pumped directly to the boilers in case the economizer is undergoing repairs.

All the hot water pipes and fittings are of brass. A water meter is set in the line so that the water pumped to any boiler or to the whole plant can be measured. With all feed water measured and all coal weighed as delivered, the economy of the plant in regular service can be accurately determined.

A perspective view of the building containing this plant is shown in Fig. 5. It is built of pressed brick with trimmings of pink Milford granite. The roof trusses are of iron. The outer covering of the roof is slate and the inner is of plaster laid on wire lath, leaving an air space to prevent condensation. The building was designed by Hartwell & Richardson, of Boston.

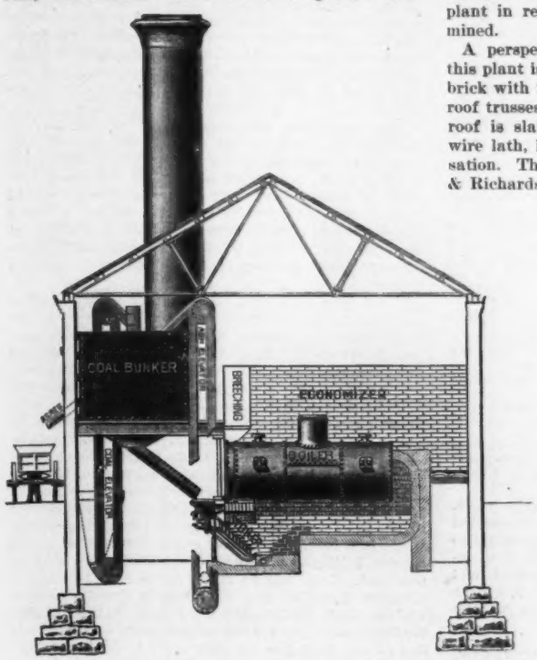



FIG. 3. SECTION THROUGH STOKER.

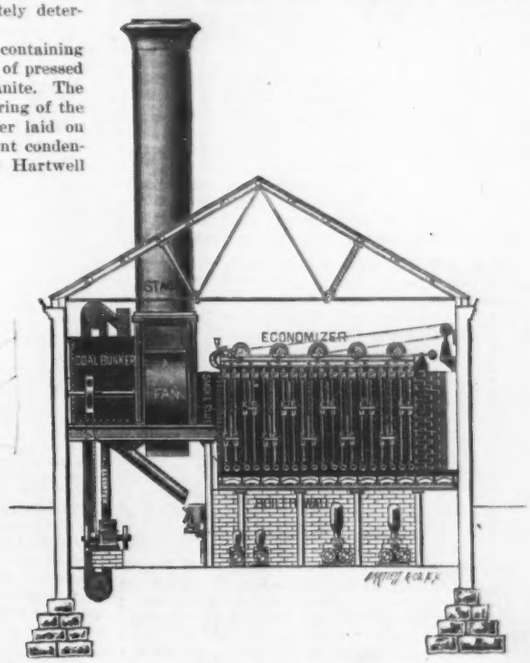



FIG. 4. SECTION THROUGH ECONOMIZER.

Mr. Wm. R. Roney, M. Am. Soc. M. E., was the engineer in charge of the work for Messrs. Westinghouse, Church, Kerr & Co.

## PERSONALS.

Gen. Thomas S. Sedgwick has been appointed City Engineer of San Diego, Cal., vice Mr. T. M. Shaw, resigned.

Mr. John Medway has been appointed Superintendent of Motive Power of the Fitchburg R. R., with office at Boston, Mass.

Mr. H. W. Reed, Atlanta, Ga., has been appointed President of the American Roadmasters' Association; and Mr. H. K. Burgwin, Grand Rapids, Mich., has been appointed Secretary.

Mr. D. B. Robinson, President of the San Antonio & Aransas Pass R. R., has resigned, and after Jan. 1 will devote himself exclusively to other railway matters in which he is interested.

Mr. R. S. Lea, formerly with Mr. M. M. Tidd, of Boston, Mass., has been appointed Lecturer in Mathematics and Drawing in the Engineering Faculty of McGill University, Montreal, Canada.

Mr. Hill Tout, City Engineer of Guelph, Ont., has resigned, the City Council having decided to dispense with the services of an engineer, but there is said to be a public movement for his reappointment.

Mr. W. I. Cook has been appointed Superintendent of Machinery and Rolling Stock of the Toledo, St. Louis and Kansas City R. R., vice Mr. John Ortton, resigned, with headquarters at Toledo, O.

Mr. J. H. Olhausen has been appointed General Superintendent of the Lehigh & Hudson River R. R.,

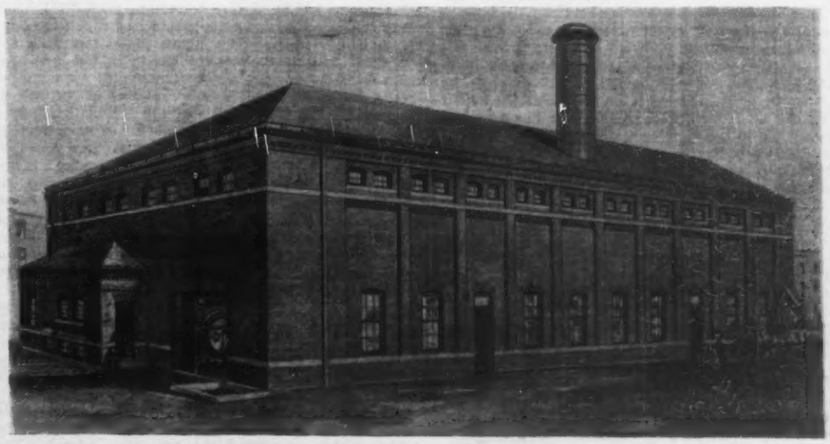


FIG. 5. PERSPECTIVE VIEW OF BOILER HOUSE.

Maj. M. B. Adams, U. S. Engineer Corps, has been appointed Lighthouse Engineer of the Ninth and Eleventh Lighthouse Districts, with office at Detroit, Mich., vice Col. Ludlow.

Mr. Douglas Curphey, M. E., has been appointed superintendent of the brass and tube mill of the Ansonia Brass & Copper Co., Ansonia, Conn.

with headquarters at Jersey City, N. J. He will continue to hold his position as General Superintendent of the Central R. R. of New Jersey.

Mr. Jacob Johann has been appointed Superintendent of Machinery of the Chicago & Alton R. R., with headquarters at Bloomington, Ill., vice Mr. A. W. Quackenbush. Mr. Johann has been at the head of the mechan-

cal department of the Missouri Pacific and Wabash railways, and has had charge of the Chicago office of the Safety Car Heating & Lighting Co.

Mr. Robert C. Morris, Chief Engineer of the Nashville, Chattanooga & St. Louis R. R., died at Nashville, Tenn., Nov. 8. He was born in Tennessee in 1817. In 1847 he was appointed as Assistant Engineer on the East Tennessee & Georgia R. R., and he became resident Engineer of that road and the East Tennessee & Virginia R. R. in 1865, and two years later Chief Engineer of the Knoxville & Charleston R. R. He was Chief Engineer of the Nashville, Chattanooga & St. Louis R. R. for the last 23 years.

Col. Alfred Spates, ex-president of the Chesapeake & Ohio Canal, died at Cumberland Md., Nov. 18. When the government, in 1862, siezed the Chesapeake & Ohio Canal by order from Secretary Stanton, he was placed in full control of the entire line from Cumberland to Georgetown. At one time during the war his loyalty was suspected, and he was arrested and confined for a short time in Fort McHenry. His imprisonment did not seem to disturb his relations with Secretary Stanton, and he was continued in charge of the canal.

Mr. J. B. Mulliken, of Detroit, Mich., died Nov. 23. After some years in railway office service he went to Escanaba, Mich., as Superintendent of the Peninsular division of the Chicago & Northwestern Ry. In 1885 he moved to Detroit and was elected Vice-President and General Manager of the Detroit, Lansing & Northern R. R., and also had under his supervision the Chicago & West Michigan and Saginaw Valley & St. Louis roads, and remained in this position until 1890, when ill-health compelled him to resign. He was a member of the Board of Public Works, and for a short time General Manager of the Citizens' Street Railway Co., of Detroit.

## SOCIETY PROCEEDINGS.

DENVER SOCIETY OF CIVIL ENGINEERS AND ARCHITECTS.—At the meeting on Nov. 23, Mr. George H. Angell read a paper on the "Heating and Ventilating of Public Buildings." He took occasion to vigorously condemn the system of "dry closets" now in use in some Denver buildings. It is the system which was tried some months ago in the Ashland high school building and said to have been found to be a nuisance. It is now being tried in the new Lincoln school.

WESTERN RAILWAY CLUB.—At the meeting on Nov. 15 Mr. A. M. Waitt's paper on "Steam Car Heating" (Eng. News, Sept. 29) was discussed. Mr. Waitt showed samples of the regulating valves and drip valves which he had described. He said that there was a saving in steam by the use of a drip valve compared with the trap. Steam is frequently seen escaping from the cars with the traps, while with the plain drip valve nothing but water escapes. The trainman is guided in regulating the drip valve by merely placing his hand on the valve. It should not be so hot as to burn his hand.

Mr. Barr thought the practical success of steam heating was greatly aided by discarding the automatic appliances which were once thought necessary.

"If to the old car stove we should attach a hopper from which the coal would feed into the stove, also a temperature regulator that when the temperature of the car raised to a certain point it would shut off the draft, and to arrange to let the ashes down when it required it, we would have the old stove fixed up in about the same style that we have in the past been endeavoring to arrange the steam heating. . . . I feel satisfied that as we go further all of us who have complications will gradually dispense with them, and come very close in our practice to experience detailed in this paper."

Mr. Halliday said that one reason why indirect systems were preferred was that the radiating pipes with the Baker heaters could be made use of. Mr. Waitt said he considered it economy to remove the Baker heater piping and put in the larger piping for direct steam without any return bends under the seat. By putting a cast iron fire pot in the Baker heater it was converted into a stove for use in emergencies.

A paper on freight car lubrication was read by Mr. J. N. Barr, and is published elsewhere in this issue. Mr. W. H. Marshall, the Secretary, presented his resignation, and Mr. C. F. Street was elected in his place. The next meeting will be held Dec. 20.

CENTRAL RAILWAY CLUB.—At the meeting on Nov. 23 the following report was submitted by the special committee on home defects of freight cars:

We would recommend for the consideration of the Club that the following defects on homebound cars, when they do not give evidence of recent origin, or of being caused by derailment or wreck, or by unusually rough handling, should be considered as home defects, and the cars should be passed home to the owners by inspectors, without a defect card:

1. Brake shoes worn out.
2. Journal bearings worn out.
3. Truck bolsters broken or cracked.
4. Truck transoms (wood) broken or cracked.
5. Body bolsters broken or cracked.
6. Spring planks broken or cracked.
7. Truck springs broken or cracked.
8. Roof boards loose or missing, or tin or iron roof loose.
9. End or side sheathing loose.
10. End or side finish loose or missing.
11. Ends or sides bulged, not broken.
12. Corner plates cracked.
13. Draft springs broken.
14. Draft timber bolts broken.
15. Center plate bolts broken.
16. Bolster guide bars broken.
17. Bolster guide blocks broken.
18. Truck truss rods broken.
19. Body truss rods broken.
20. Pedestals cracked.
21. Oil box covers missing or broken.
22. Spread trucks.
23. Loose dead blocks.
24. Cars low on trucks where wheels come in contact with intermediate timbers.
25. Side bearings and bolts broken.
26. Arch bars broken or cracked.
27. Decayed timbers.
28. Leaky roofs.

The committee would say that we find an arrangement similar to this is, and has been, in force at several large inspection points for a number of months, and as yet we have heard of only the most satisfactory results coming from it. As the defects above mentioned are a class of old defects that are quite prevalent, and as a great many defect cards in a year have to be issued for these defects, the greater proportion of which are never used as authority for bills, your committee believe that great relief would be experienced at inspection points through a reduced number of defect cards applied, and also in a quite considerable reduction in delays to cars on account of questions arising from defects of the classes mentioned. Your committee believe further that with an understanding as above outlined, when a car belonging to a private company was found to have defects as mentioned, there could be no question as to the propriety and validity of a bill rendered against the owner of the private car, under Rule 10, whereas at the present time there is the prospect of having such bills questioned and invalidated. A. M. Waitt, J. R. Petrie, W. H. Raynolds.

The discussion on this report was rather unfavorable. It was shown that Nos. 1, 2, 3, 5, 6 and 7 were covered by Rule 8, so these were omitted and No. 14 was also struck out. Nos. 14 and 25 were altered so as to require the safe running of the car to be secured, and the remainder of the report was adopted. The next meeting will be the annual one and will be held on Jan. 25.

AMERICAN INSTITUTE OF MINING ENGINEERS.—The sixty-fourth meeting will be held at Montreal, Canada, beginning on Tuesday evening, Feb. 21, 1893. Mr. B. T. A. Bell, Ottawa, Canada, represents, until further notice, the Local Committee. The Mining Society of Nova Scotia, the Abestos Club, the Provincial Mining Association of Ontario, and the General Mining Association of the Province of Quebec, have determined to hold in Montreal, during the week of this meeting, their inter-provincial mining conference. An excursion is contemplated to the collieries and ironworks of Pictou County, Nova Scotia.

In response to the special circular of March last, inviting contributions from members and associates toward the maintenance of an International Engineering Headquarters in Chicago during the World's Columbian Exposition, and also for the special expenses of the Institute in connection with the exposition (especially with the two divisions of the proposed International Engineering Congress, representing, respectively, mining and metallurgy, for the conduct of which the Institute will be responsible), about $4,000 has been subscribed. This is the amount which, in the opinion of the Council, should fairly be contributed by the members of the Institute toward the fund of $15,000, required for the maintenance of the International Engineering Headquarters—the remainder of said fund being provided by the members of the other American engineering societies engaged in the enterprise. It will be seen, therefore, that the amount of the subscription, as it now stands, leaves no provision for the special expenses of the Institute in connection with the exposition or the congress. Many members who intend to subscribe to this fund have delayed action hitherto, and this statement is made at the present time in order to emphasize the fact that further subscriptions to the Columbian Exposition Fund of the Institute, which will be devoted to the special expenses of the Institute itself, and to the particular benefit of its own members, should now be promptly made, so that the means at disposal for such purposes may be known, and plans may be definitely formed.

It should be added that these inevitable expenses will not include the maintenance of headquarters, either within or without the exposition grounds. The members of the Institute will share with other contributors the privileges of the fully equipped and attractive International Engineering Headquarters in the city of Chicago, outside of the exposition, and the suite of rooms in the Mines and Mining Building, tendered to the Institute by Mr. F. J. V. Skiff, the Chief of that Department, has been, with his consent, offered to the Joint Committee of Associated Engineering Societies and cordially accepted, to be used as an International Engineering Headquarters within the exposition. But there will remain, unquestionably, many items of necessary expense connected with the double meeting of the Institute, constituting two divisions of the World's Engineering Congress. Subscriptions to the Columbian Exposition Fund of the Institute should be sent to J. F. Lewis, 23 Park Place, New York City.

To control the expenditure of this fund, and, in general, to take charge of all matters involving the relations of the Institute to the Columbian Exposition (excepting only the proceedings of the two divisions of the Congress aforesaid), the Council has created a representative Columbian Exposition Committee of the Institute, the full membership of which will be announced hereafter, and which has been organized by the election of President John Birkinbine as Chairman, and Dr. David T. Day, U. S. Geological Survey, Washington, D. C., as Secretary.

This committee will endeavor to do all that is possible for the credit of the Institute and the advantage of members visiting Chicago next summer; but definite plans cannot be made until the amount of available means shall have been ascertained. At the present time, however, there is one matter, in which the committee may perhaps be useful to members of the Institute; and with the view of finding out whether such service is practicable, the present announcement is made.

It has been suggested, namely, that many members intending to spend longer or shorter periods in Chicago, during the summer of 1893 (whether including or not including the first week of August, when the Congress will take place), would be glad to secure lodgings at reasonable price; and that, if they could only communicate with one another, they might be able to club together in renting suitable rooms, to be occupied, perhaps, in succession, throughout the season.

Whether such plans are feasible remains to be seen; but, as a means of determining the question, the suggestion is made, that all members desiring to participate in joint arrangements of this kind write at once to Dr. Day, secretary of the above committee, stating when, how long, and for how many persons they would require lodgings, with any other particulars deemed pertinent. They will be informed as soon as possible whether anything can be done to facilitate their wishes, either by bringing them into mutual relations for further and private arrangements, or by the formation of any more general plan.

R. W. Raymond, Secy.

ROADMASTERS' ASSOCIATION OF AMERICA.—The first session of the tenth annual convention was held at the Read House, Chattanooga, Tenn., Nov. 15. No technical work of importance was accomplished. The remaining sessions were held at Atlanta, on the two following days. The Committee on Rails, Messrs. R. Caffrey and D. H. Lovell, reported that chemical composition of rails should be left to the manufacturers. The distribution of weight in the section should be such as to cause the rail to leave the rolls at uniform heat in all parts and thus avoid annealing due to a too high heat in the head. To obtain best results the head should be broad and shallow, with nearly vertical sides and top corner radius of ¼ in. to 5-16 in. The distribution of weight should be about as follows: Head, 43%; web, 22%; flange, 35%. The width of the flange should be not less than the height of the rail, and the edges of the flange should be vertical to avoid shearing spikes. The weight for standard gage track should be not less than 70 lbs. per yd.

A voluminous report on rail joints was then read. The Association appointed a committee on this subject at its Detroit convention two years ago and set out to conduct a series of official tests on five joints. Three more joints have since been added and the committee wound up its report with a recommendation that three more should be officially "investigated."

The result of the trials thus far may be summed up about as follows: The Cloud joint (Eng. News, Jan. 11, 1890) has not been pushed on the market owing to the death of Mr. C. H. Dunham, who had it in charge. The Weber joint (Eng. News, Dec. 20, 1890) is said to be in use on the New York, New Haven & Hartford; but the committee had no official information as to the results obtained.

The Long truss joint (Eng. News, Dec. 28, 1889) has been used on four roads in the Northwest with excellent satisfaction. McConway & Torley's reinforcement to the ordinary angle bar (Eng. News, April 21, 1888) is in use on half a dozen roads and gives excellent results. Fisher's latest improved joint, in which the heads of the rails as well as the flanges are held firmly from horizontal deflection, is in use on the Philadelphia & Reading R. R., near Langhorne, Pa., and has been about 17 months in service, with good results. The Thompson continuous rail joint has been used on a considerable number of roads, both east and west, and with generally good results. The following letters criticizing the joints were read:

I send you a report from Roadmaster Edward Laas, regarding 400 McConway & Torley and 400 Long truss joints, which are in our track. We have put in five miles of Long truss joints on 67-lb. steel rail, and about

the same number of McConway & Torley joints and also of the Continuous rail joints. The McConway & Torley seems to hold the rail better than the Long as regards evenness of expansion and contraction, for while the percentage of McConway & Torley joints out of surface is a trifle more, they ride better than the Long, which may be due to improper tamping, on account of the men not understanding the truss joint. The Continuous has been in too short a time to enable us to make a report.

Mr. Laas describes the method of laying the joints as follows: "The joints were placed in reverse order in the two tracks, so that the McConway & Torley in one track were opposite to the Long truss joints in the other. The steel was laid 'broken joints' and new ties were put under each joint. The tracks were surfaced throughout. From July 1, 1891, to July 1, 1892, 4,268 freight and 3,600 passenger trains were run over each track, also 365 transfer trains. The amount of tonnage passing over each track in trains, freight, etc., was 4,084,375 tons. I have made an examination of all these joints and find results on the high speed track as follows:

| Joint. | McCon. & Tor. | Long. | 6-bolt angle-bar. |
|---|---|---|---|
| Per cent. low..... | 45 | 20 | 30 |
| Per cent good..... | 55 | 80 | 70 |
| On the low speed track I found: | | | |
| Per cent. low..... | 35 | .. | 35 |
| Per cent. good..... | 65 | .. | 65 |

"I do not consider this a satisfactory test of these joints, as the track has not been entirely picked up since it was surfaced. Next year at this time we should be able to get data by which we can easily determine the durability and staying up qualities of these different joints, as the track will all have been picked up by section men and tamped with bars." J. B. Moll, Gen. Roadmaster, C., M. & St. P. Ry.

Nothing but constant attention has preserved the rail ends with the Long truss joint from batter. Joint ties do not last as long as they do under our standard 24-in. angle bar joint. There is a tendency on the part of the ties to buckle, throwing all the load on the extreme ends of the base plate, so that in many cases there is half an inch clearance under the plate at facing side of joint ties.—J. H. Conlen, C. R. I. & Pac. Ry.

In reference to the Thompson continuous rail joint would say they were put on 60-lb. steel in the month of May, 1891. The steel was laid in July, 1889, and is in good condition. During the season of 1891 the weather was very dry and we were unable to get a satisfactory trial of this joint. During the months of May and June this year we had considerable wet weather that softened our roadbed, and during that time we found that the continuous joint does not hold up any better than the common angle bar.—Wm. Manley, C. & N. W. Ry.

Other letters praising each of the joints were read, and the accompanying table summarizing results in service was submitted. The following letter concerning the miter cut rail was read:

We have in use on our road a large number of rails with ends miter cut instead of square. They are fastened with our standard six-hole angle bars. We have had them in use exclusively for about three years and they are proving very satisfactory. The perceptible blow of passing wheels over them is entirely removed and there are no low joints where they are in use.—R. Caffrey, Lehigh Valley.

In conclusion the committee recommended the Fisher, the Long truss, and the McConway & Torley joints "for further trial." The Weber, the Cloud, and the Thomson Continuous joints were considered to be practically angle bar joints and were recommended to be "dropped from further consideration of new appliances, but considered as improved appliances,"—which appears to be a distinction without a difference. The Heath, Niles, Eno and Price joints were recommended for further investigation by a committee of the Association.

A report was then read by the Committee on Methods of Fastening Rails to Ties. It recommended the Bush interlocking bolts for use on bridges and trestles, and steel spikes for ordinary track, with tie plates on all soft wood ties and on all curves.

The report on switch stands recommended an automatic stand which would permit a train to pass over it trailing and would be thrown to the proper position for the train by the pressure of the wheels against the points, the target at the same time turning to indicate the position of the switch.

Main line switches should have targets not less than 8 ft. high. For yard switches, automatic ground stands, or stands not more than 3 ft. 2 ins. above the top of the rail were recommended. Switch stands should be set on the right hand side when facing the point of the switch, not less than 6 ft. from the stand to the nearest track rail. If more than one switch leads from the main track at one end of the yard or station, the stands should either vary in height, placing the lowest stand first, or should be set at variable distances from the rail, or both precautions should be observed to give a distinct view of each switch target from the locomotive. Single targets were recommended.

The discussion on this report was chiefly on the last recommendation, and by an almost unanimous vote the report was amended to recommend the use of double targets. Reports from the various switch manufacturers showed that practically their entire output was made with double targets, except at the Ramapo Iron Works and the Elliott works, which stated that about half their orders were for single target stands.

A paper on "Work Trains and Their Handling by Dispatchers," prepared by a train dispatcher on the South Carolina R. R. was presented as the report of

Comparative Tests of Rail Joints Reported to the Roadmasters' Association of America.

| | | Track. | | | | | | Rail | | | Ballast. | | Ties. | | No. daily trains. | | Av. cars per train. | | Joints placed in track. | | No joints. | Present condition of joints. | | | | Labor compared with angle bar joints. | | Are nut locks necessary? | Do spikes start at joints? | Is spacing for expansion & cont'r'n kept even? | What, if any breakage? | Ry. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Alinement. | | Grade. | | Cut or fill. | Wt., lbs. | Age. | | Condition. | Kind. | Condition. | Kind. | Condition | Pass. | Frt. | Pass. | Frt. | Month. | Year. | | In surface. | | Low. | | Laying. | Maintaining. | | | | | |
| | | | | L. | T. | | | L. | T. | | | | | | | | | | | | | No. | P. c. | No. | P. c. | | | | | | | |
| Long's Truss. | Tan. | | | | | F | 67 | | | G | Gr. | F | Hem | F | 18 | 26 | 4 | 25 | 3 | 59 | 4 miles | 100 | | 3 | Same | Less | Yes | Yes | Yes | None | |
| | 2° C & T | | | | | C F | 72 | 3 | | G | Gr. | G | Oak | G | 8 | 16 | 1 | 25 | 3 | 59 | 770 | 100 | | 3 | 10% | 10% | No | No | No | None | |
| | Tan. | | | L. | T. | F | 72 | 3 | | G | Gr. | G | Oak | G | 8 | 16 | 1 | 25 | 3 | 59 | 480 | 100 | | 3 | 10% | 10% | No | No | No | None | |
| | Tan. | | | + 1/8 | − 1/8 | C F | 72 | 3¼ | | G | Gr. | G | Oak | G | 8 | 16 | 1 | 25 | 3 | 59 | 542 | 100 | | 3 | 15% | 10% | No | No | No | None | |
| | Tan. | | | − 5/8 | | F | 70 | 3¼ | | F | Clin. | F | Hn'tzd | F | 12 | 20 | 6 | 25 | 3 | 59 | 610 | 100 | | 4 | 15% | 10% | No | No | No | None | |
| McConway & Torley | Tan. | | | | | C F | 75 | 4 y | | G | Gr. | G | Oak | G | 10 | 13 | 5 | 25 | 7 | 91 | 400 | 100 | | 4 | More | Less | Yes | Yes | Yes | None | |
| | Tan. | | | + − 30′ | | F | 75 | 4 y | | G | Gr. | G | Hem | F | 10 | 13 | 5 | 25 | 7 | 91 | 344 | 100 | | 4 | More | Less | Yes | Yes | Yes | None | |
| | Tan. | | | | | C F | 75 | 4 y | | G | Gr. | G | Oak | G | 10 | 13 | 5 | 25 | 7 | 91 | 636 | 240 | | 5 | More | Less | Yes | Yes | Yes | None | |
| | Tan. | | | + 30′ | | C | 75 | 4 y | | G | Gr. | G | Oak | G | 10 | 13 | 5 | 25 | 7 | 91 | 6 miles | 240 | | 5 | More | Less | Yes | Yes | Yes | None | |
| | Tan. | | | + − 30′ | | C F | 65 | 4 y | | G | Gr. | G | Oak | G | 10 | 13 | 5 | 25 | 7 | 91 | 200 | 60 | | 5 | More | Less | Yes | Yes | Yes | None | |
| | Tan. | | | + 30′ | | F | 75 | 4 y | | G | Gr. | G | Oak | G | 10 | 13 | 5 | 25 | 7 | 91 | 200 | 60 | | 5 | More | Less | Yes | Yes | Yes | None | |
| | Tan. | | | + 30′ | | C F | 65 | 4 y | | G | Gr. | G | Oak | G | 10 | 13 | 5 | 25 | 7 | 91 | 8 | 60 | | 5 | More | Less | Yes | Yes | Yes | None | |
| | Tan. | | | + 30′ | | C | 65 | 4 y | | G | Gr. | G | Oak | G | 10 | 13 | 5 | 25 | 7 | 91 | 200 | 92 | | 5 | More | Less | Yes | Yes | Yes | None | |
| Fisher. | Tan. | | | | | C F | 90 | 3 y | | G | Gr. | G | Oak | G | 20 | 26 | 6 | 35 | 12 | 90 | 50 | 180 | 100 | 3 | 25% | Less | Yes | Yes | Yes | None | |
| | 1° C & T | | | | | C F | 90 | 3 y | | G | Gr. | G | Oak | G | 20 | 26 | 6 | 35 | 12 | 90 | 49 | 190 | 100 | 3 | 25% | Less | Yes | Yes | Yes | None | |
| | Tan. | | | − 26′ | | C F | 90 | 3 y | | G | Gr. | G | Oak | G | 20 | 26 | 6 | 35 | 12 | 90 | 200 | 8 | 100 | 3 | 25% | Less | Yes | Yes | Yes | None | |
| | Tan. | | | + − 0 | | C F | 90 | 3 y | | G | Gr. | G | Oak | G | 20 | 26 | 6 | 35 | 12 | 90 | 50 | 190 | 95 | 3 | 25% | Less | Yes | Yes | Yes | None | |
| | Tan. | | | + 26 | | C F | 72 | 3 y | | G | Gr. | G | Oak | G | 20 | 26 | 6 | 35 | 12 | 90 | 92 | 20 | 97½ | 3 | 25% | Less | Yes | Yes | Yes | None | |
| | Tan. | | | | | C F | 72 | 3 y | | G | Gr. | G | Oak | G | 20 | 26 | 6 | 35 | 12 | 90 | 60 | 92 | 100 | 3 | 25% | Less | Yes | Yes | Yes | None | |
| | Tan. | | | L. | T. | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Thompson's continuous. | | | | + 1/8 | − 1/8 | F | 67 | 3 y | | G | Gr. | F | Hem | F | 18 | 26 | 4 | 25 | 3 | 59 | 4 miles | 100 | 99¾ | 3 | Same | Less | Yes | Yes | Yes | None | |
| | | | | − 5/8 | | C F | 72 | 3¼ | | G | Gr. | G | Oak | G | 8 | 16 | 1 | 25 | 3 | 59 | 770 | 100 | 99¾ | 3 | 10% | 10% | No | No | No | None | |
| | | | | | | F | 72 | 3¼ | | G | Gr. | G | Oak | G | 8 | 16 | 1 | 25 | 3 | 59 | 480 | 100 | 99¾ | 3 | 15% | 10% | No | No | No | None | |
| | | | | | | C F | 72 | 3¼ | | G | Gr. | G | Oak | G | 8 | 16 | 1 | 25 | 3 | 59 | 542 | 100 | 99¾ | 3 | 15% | 10% | No | No | No | None | |
| | | | | | | F | 70 | 4 y | | F | Clin. | F | Hn'tzd | F | 12 | 20 | 6 | 25 | 3 | 59 | 610 | 100 | 99¾ | 4 | 15% | 10% | No | No | No | None | |
| | | | | | | C F | 72 | 4 y | | G | Gr. | G | Oak | G | 10 | 13 | 5 | 25 | 7 | 91 | 400 | 100 | 99¾ | 4 | More | Less | Yes | Yes | Yes | None | |
| | | | | | | F | 75 | 4 y | | G | Gr. | G | Hem | F | 10 | 13 | 5 | 25 | 7 | 91 | 344 | 100 | 99¾ | 4 | More | Less | Yes | Yes | Yes | None | |
| | | | | | | C F | 75 | 4 y | | G | Gr. | G | Oak | G | 10 | 13 | 5 | 25 | 7 | 91 | 636 | 240 | 99¾ | 5 | More | Less | Yes | Yes | Yes | None | |
| | | | | | | C | 75 | 4 y | | G | Gr. | G | Oak | G | 10 | 13 | 5 | 25 | 7 | 91 | 6 miles | 240 | 99¾ | 5 | More | Less | Yes | Yes | Yes | None | |
| | | | | | | C F | 65 | 4 y | | G | Gr. | G | Oak | G | 10 | 13 | 5 | 25 | 7 | 91 | 200 | 60 | 99¾ | 5 | More | Less | Yes | Yes | Yes | None | |
| | | | | | | F | 75 | 4 y | | G | Gr. | G | Oak | G | 10 | 13 | 5 | 25 | 7 | 91 | 200 | 60 | 99¾ | 5 | More | Less | Yes | Yes | Yes | None | |
| | | | | | | C F | 65 | 4 y | | G | Gr. | G | Oak | G | 10 | 13 | 5 | 25 | 7 | 91 | 8 | 60 | 99¾ | 5 | More | Less | Yes | Yes | Yes | None | |
| | | | | | | C | 65 | 4 y | | G | Gr. | G | Oak | G | 10 | 13 | 5 | 25 | 7 | 91 | 200 | 92 | 99¾ | 5 | More | Less | Yes | Yes | Yes | None | |
| | | | | | | C F | 90 | 3 y | | G | Gr. | G | Oak | G | 20 | 26 | 6 | 35 | 12 | 90 | 50 | 180 | 100 | 3 | 25% | Less | Yes | Yes | Yes | None | |
| | | | | | | C F | 90 | 3 y | | G | Gr. | G | Oak | G | 20 | 26 | 6 | 35 | 12 | 90 | 49 | 190 | 100 | 3 | 25% | Less | Yes | Yes | Yes | None | |
| | | | | | | C F | 90 | 3 y | | G | Gr. | G | Oak | G | 20 | 26 | 6 | 35 | 12 | 90 | 200 | 8 | 100 | 3 | 25% | Less | Yes | Yes | Yes | None | |
| | | | | | | C F | 90 | 3 y | | G | Gr. | G | Oak | G | 20 | 26 | 6 | 35 | 12 | 90 | 50 | 190 | 95 | 3 | 25% | Less | Yes | Yes | Yes | None | |
| | | | | | | C F | 72 | 3 y | | G | Gr. | G | Oak | G | 20 | 26 | 6 | 35 | 12 | 90 | 92 | 20 | 97¼ | 3 | 25% | Less | Yes | Yes | Yes | None | |
| | | | | | | C F | 72 | 3 y | | G | Gr. | G | Oak | G | 20 | 26 | 6 | 35 | 12 | 90 | 60 | 92 | 100 | 3 | 25% | Less | Yes | Yes | Yes | None | |
| Thompson's continuous. | | | | | | F | 67 | 3 y | | G | Gr. | F | Hem | F | 18 | 26 | 4 | 25 | 3 | 59 | 4 miles | 100 | | 3 | Same | Less | Yes | Yes | Yes | None | |
| | | | | | | C F | 72 | 3¼ | | G | Gr. | G | Oak | G | 8 | 16 | 1 | 25 | 3 | 59 | 770 | 100 | | 3 | 10% | 10% | No | No | No | None | |
| | | | | | | F | 72 | 3¼ | | G | Gr. | G | Oak | G | 8 | 16 | 1 | 25 | 3 | 59 | 480 | 100 | | 3 | 15% | 10% | No | No | No | None | |
| | | | | | | C F | 72 | 3¼ | | G | Gr. | G | Oak | G | 8 | 16 | 1 | 25 | 3 | 59 | 542 | 100 | | 3 | 15% | 10% | No | No | No | None | |
| | | | | | | F | 70 | 4 y | | F | Clin. | F | Hn'tzd | F | 12 | 20 | 6 | 25 | 3 | 59 | 610 | 100 | | 4 | 15% | 10% | No | No | No | None | |
| | | | | | | C F | 72 | 4 y | | G | Gr. | G | Oak | G | 10 | 13 | 5 | 25 | 7 | 91 | 400 | 100 | | 4 | More | Less | Yes | Yes | Yes | None | |
| | | | | | | F | 75 | 4 y | | G | Gr. | G | Hem | F | 10 | 13 | 5 | 25 | 7 | 91 | 344 | 100 | | 4 | More | Less | Yes | Yes | Yes | None | |
| | | | | | | C F | 75 | 4 y | | G | Gr. | G | Oak | G | 10 | 13 | 5 | 25 | 7 | 91 | 636 | 240 | | 5 | More | Less | Yes | Yes | Yes | None | |
| | | | | | | C | 75 | 4 y | | G | Gr. | G | Oak | G | 10 | 13 | 5 | 25 | 7 | 91 | 6 miles | 240 | | 5 | More | Less | Yes | Yes | Yes | None | |
| | | | | | | C F | 65 | 4 y | | G | Gr. | G | Oak | G | 10 | 13 | 5 | 25 | 7 | 91 | 200 | 60 | | 5 | More | Less | Yes | Yes | Yes | None | |
| | | | | | | F | 75 | 4 y | | G | Gr. | G | Oak | G | 10 | 13 | 5 | 25 | 7 | 91 | 200 | 60 | | 5 | More | Less | Yes | Yes | Yes | None | |
| | | | | | | C F | 65 | 4 y | | G | Gr. | G | Oak | G | 10 | 13 | 5 | 25 | 7 | 91 | 8 | 60 | | 5 | More | Less | Yes | Yes | Yes | None | |
| | | | | | | C | 65 | 4 y | | G | Gr. | G | Oak | G | 10 | 13 | 5 | 25 | 7 | 91 | 200 | 92 | | 5 | More | Less | Yes | Yes | Yes | None | |
| | | | | | | C F | 90 | 3 y | | G | Gr. | G | Oak | G | 20 | 26 | 6 | 35 | 12 | 90 | 50 | 180 | 100 | 3 | 25% | Less | Yes | Yes | Yes | None | |
| | | | | | | C F | 90 | 3 y | | G | Gr. | G | Oak | G | 20 | 26 | 6 | 35 | 12 | 90 | 49 | 190 | 100 | 3 | 25% | Less | Yes | Yes | Yes | None | |
| | | | | | | C F | 90 | 3 y | | G | Gr. | G | Oak | G | 20 | 26 | 6 | 35 | 12 | 90 | 200 | 8 | 100 | 3 | 25% | Less | Yes | Yes | Yes | None | |
| | | | | | | C F | 90 | 3 y | | G | Gr. | G | Oak | G | 20 | 26 | 6 | 35 | 12 | 90 | 50 | 190 | 95 | 3 | 25% | Less | Yes | Yes | Yes | None | |
| | | | | | | C F | 72 | 3 y | | G | Gr. | G | Oak | G | 20 | 26 | 6 | 35 | 12 | 90 | 92 | 20 | 97¼ | 3 | 25% | Less | Yes | Yes | Yes | None | |
| | | | | | | C F | 72 | 3 y | | G | Gr. | G | Oak | G | 20 | 26 | 6 | 35 | 12 | 90 | 60 | 92 | 100 | 3 | 25% | Less | Yes | Yes | Yes | None | |
| Fisher. | Tan. | | | | | C F | 90 | 3 y | | G | Gr. | G | Oak | G | 20 | 26 | 6 | 35 | 12 | 90 | 50 | 180 | 100 | 3 | 25% | Less | Yes | Yes | Yes | None | C. M. & St. P. |
| | 1° C & T | | | | | C F | 90 | 3 y | | G | Gr. | G | Oak | G | 20 | 26 | 6 | 35 | 12 | 90 | 49 | 190 | 100 | 3 | 25% | Less | Yes | Yes | Yes | None | C. & N. W. |
| | Tan. | | | − 26′ | | C F | 90 | 3 y | | G | Gr. | G | Oak | G | 20 | 26 | 6 | 35 | 12 | 90 | 200 | 8 | 100 | 3 | 25% | Less | Yes | Yes | Yes | None | C. M. & St. P. |
| | Tan. | | | + − 0 | | C F | 90 | 3 y | | G | Gr. | G | Oak | G | 20 | 26 | 6 | 35 | 12 | 90 | 50 | 190 | 95 | 3 | 25% | Less | Yes | Yes | Yes | None | C. & N. W. |
| | Tan. | | | + 26 | | C F | 72 | 3 y | | G | Gr. | G | Oak | G | 20 | 26 | 6 | 35 | 12 | 90 | 92 | 20 | 97¼ | 3 | 25% | Less | Yes | Yes | Yes | None | C. M. & St. P. |
| | Tan. | | | | | C F | 72 | 3 y | | G | Gr. | G | Oak | G | 20 | 26 | 6 | 35 | 12 | 90 | 60 | 92 | 100 | 3 | 25% | Less | Yes | Yes | Yes | None | C. & N. W. |
| Thompson's continuous. | | | | | | F | 67 | 3 y | | G | Gr. | F | Hem | F | 18 | 26 | 4 | 25 | 3 | 59 | 4 miles | 100 | | 3 | Same | Less | Yes | Yes | Yes | None | F. & P. M. |
| | | | | | | C F | 72 | 3¼ | | G | Gr. | G | Oak | G | 8 | 16 | 1 | 25 | 3 | 59 | 770 | 100 | | 3 | 10% | 10% | No | No | No | None | C. & N. W. |
| | | | | | | F | 72 | 3¼ | | G | Gr. | G | Oak | G | 8 | 16 | 1 | 25 | 3 | 59 | 480 | 100 | | 3 | 15% | 10% | No | No | No | None | " |
| | | | | | | C F | 72 | 3¼ | | G | Gr. | G | Oak | G | 8 | 16 | 1 | 25 | 3 | 59 | 542 | 100 | | 3 | 15% | 10% | No | No | No | None | C. R. I. & P. |
| | | | | | | F | 70 | 4 y | | F | Clin. | F | Hn'tzd | F | 12 | 20 | 6 | 25 | 3 | 59 | 610 | 100 | | 4 | 15% | 10% | No | No | No | None | C. M. & St. P. |
| | | | | | | C F | 72 | 4 y | | G | Gr. | G | Oak | G | 10 | 13 | 5 | 25 | 7 | 91 | 400 | 100 | | 4 | More | Less | Yes | Yes | Yes | None | C. & N. W. |
| | | | | | | F | 75 | 4 y | | G | Gr. | G | Hem | F | 10 | 13 | 5 | 25 | 7 | 91 | 344 | 100 | | 4 | More | Less | Yes | Yes | Yes | None | F. & P. M. |
| | | | | | | C F | 75 | 4 y | | G | Gr. | G | Oak | G | 10 | 13 | 5 | 25 | 7 | 91 | 636 | 240 | | 5 | More | Less | Yes | Yes | Yes | None | C. & N. W. |
| | | | | | | C | 75 | 4 y | | G | Gr. | G | Oak | G | 10 | 13 | 5 | 25 | 7 | 91 | 6 miles | 240 | | 5 | More | Less | Yes | Yes | Yes | None | " |
| | | | | | | C F | 65 | 4 y | | G | Gr. | G | Oak | G | 10 | 13 | 5 | 25 | 7 | 91 | 200 | 60 | | 5 | More | Less | Yes | Yes | Yes | None | C. R. I. & P. |
| | | | | | | F | 75 | 4 y | | G | Gr. | G | Oak | G | 10 | 13 | 5 | 25 | 7 | 91 | 200 | 60 | | 5 | More | Less | Yes | Yes | Yes | None | C. M. & St. P. |
| | | | | | | C F | 65 | 4 y | | G | Gr. | G | Oak | G | 10 | 13 | 5 | 25 | 7 | 91 | 8 | 60 | | 5 | More | Less | Yes | Yes | Yes | None | " |
| | | | | | | C | 65 | 4 y | | G | Gr. | G | Oak | G | 10 | 13 | 5 | 25 | 7 | 91 | 200 | 92 | | 5 | More | Less | Yes | Yes | Yes | None | C. & N. W. |
| | | | | | | C F | 90 | 3 y | | G | Gr. | G | Oak | G | 20 | 26 | 6 | 35 | 12 | 90 | 50 | 180 | 100 | 3 | 25% | Less | Yes | Yes | Yes | None | C. M. & St. P. |
| | | | | | | C F | 90 | 3 y | | G | Gr. | G | Oak | G | 20 | 26 | 6 | 35 | 12 | 90 | 49 | 190 | 100 | 3 | 25% | Less | Yes | Yes | Yes | None | C. & N. W. |
| | | | | | | C F | 90 | 3 y | | G | Gr. | G | Oak | G | 20 | 26 | 6 | 35 | 12 | 90 | 200 | 8 | 100 | 3 | 25% | Less | Yes | Yes | Yes | None | C. M. & St. P. |
| | | | | | | C F | 90 | 3 y | | G | Gr. | G | Oak | G | 20 | 26 | 6 | 35 | 12 | 90 | 50 | 190 | 95 | 3 | 25% | Less | Yes | Yes | Yes | None | C. & N. W. |
| | | | | | | C F | 72 | 3 y | | G | Gr. | G | Oak | G | 20 | 26 | 6 | 35 | 12 | 90 | 92 | 20 | 97¼ | 3 | 25% | Less | Yes | Yes | Yes | None | C. M. & St. P. |
| | | | | | | C F | 72 | 3 y | | G | Gr. | G | Oak | G | 20 | 26 | 6 | 35 | 12 | 90 | 60 | 92 | 100 | 3 | 25% | Less | Yes | Yes | Yes | None | C. & N. W. |
| Thompson's continuous. | | | | | | F | 67 | 3 y | | G | Gr. | F | Hem | F | 18 | 26 | 4 | 25 | 3 | 59 | 4 miles | 100 | | 3 | Same | Less | Yes | Yes | Yes | None | F. & P. M. |
| | | | | | | C F | 72 | 3¼ | | G | Gr. | G | Oak | G | 8 | 16 | 1 | 25 | 3 | 59 | 770 | 100 | | 3 | 10% | 10% | No | No | No | None | C. & N. W. |
| | | | | | | F | 72 | 3¼ | | G | Gr. | G | Oak | G | 8 | 16 | 1 | 25 | 3 | 59 | 480 | 100 | | 3 | 15% | 10% | No | No | No | None | " |
| | | | | | | C F | 72 | 3¼ | | G | Gr. | G | Oak | G | 8 | 16 | 1 | 25 | 3 | 59 | 542 | 100 | | 3 | 15% | 10% | No | No | No | None | C. R. I. & P. |
| | | | | | | F | 70 | 4 y | | F | Clin. | F | Hn'tzd | F | 12 | 20 | 6 | 25 | 3 | 59 | 610 | 100 | | 4 | 15% | 10% | No | No | No | None | C. M. & St. P. |
| | | | | | | C F | 72 | 4 y | | G | Gr. | G | Oak | G | 10 | 13 | 5 | 25 | 7 | 91 | 400 | 100 | | 4 | More | Less | Yes | Yes | Yes | None | C. & N. W. |
| | | | | | | F | 75 | 4 y | | G | Gr. | G | Hem | F | 10 | 13 | 5 | 25 | 7 | 91 | 344 | 100 | | 4 | More | Less | Yes | Yes | Yes | None | F. & P. M. |
| | | | | | | C F | 75 | 4 y | | G | Gr. | G | Oak | G | 10 | 13 | 5 | 25 | 7 | 91 | 636 | 240 | | 5 | More | Less | Yes | Yes | Yes | None | C. & N. W. |
| | | | | | | C | 75 | 4 y | | G | Gr. | G | Oak | G | 10 | 13 | 5 | 25 | 7 | 91 | 6 miles | 240 | | 5 | More | Less | Yes | Yes | Yes | None | " |
| | | | | | | C F | 65 | 4 y | | G | Gr. | G | Oak | G | 10 | 13 | 5 | 25 | 7 | 91 | 200 | 60 | | 5 | More | Less | Yes | Yes | Yes | None | C. R. I. & P. |
| | | | | | | F | 75 | 4 y | | G | Gr. | G | Oak | G | 10 | 13 | 5 | 25 | 7 | 91 | 200 | 60 | | 5 | More | Less | Yes | Yes | Yes | None | C. M. & St. P. |
| | | | | | | C F | 65 | 4 y | | G | Gr. | G | Oak | G | 10 | 13 | 5 | 25 | 7 | 91 | 8 | 60 | | 5 | More | Less | Yes | Yes | Yes | None | " |
| | | | | | | C | 65 | 4 y | | G | Gr. | G | Oak | G | 10 | 13 | 5 | 25 | 7 | 91 | 200 | 92 | | 5 | More | Less | Yes | Yes | Yes | None | C. & N. W. |
| | | | | | | C F | 90 | 3 y | | G | Gr. | G | Oak | G | 20 | 26 | 6 | 35 | 12 | 90 | 50 | 180 | 100 | 3 | 25% | Less | Yes | Yes | Yes | None | C. M. & St. P. |
| | | | | | | C F | 90 | 3 y | | G | Gr. | G | Oak | G | 20 | 26 | 6 | 35 | 12 | 90 | 49 | 190 | 100 | 3 | 25% | Less | Yes | Yes | Yes | None | C. & N. W. |
| | | | | | | C F | 90 | 3 y | | G | Gr. | G | Oak | G | 20 | 26 | 6 | 35 | 12 | 90 | 200 | 8 | 100 | 3 | 25% | Less | Yes | Yes | Yes | None | C. M. & St. P. |
| | | | | | | C F | 90 | 3 y | | G | Gr. | G | Oak | G | 20 | 26 | 6 | 35 | 12 | 90 | 50 | 190 | 95 | 3 | 25% | Less | Yes | Yes | Yes | None | C. & N. W. |
| | | | | | | C F | 72 | 3 y | | G | Gr. | G | Oak | G | 20 | 26 | 6 | 35 | 12 | 90 | 92 | 20 | 97¼ | 3 | 25% | Less | Yes | Yes | Yes | None | C. M. & St. P. |
| | | | | | | C F | 72 | 3 y | | G | Gr. | G | Oak | G | 20 | 26 | 6 | 35 | 12 | 90 | 60 | 92 | 100 | 3 | 25% | Less | Yes | Yes | Yes | None | C. & N. W. |

the committee on that subject and was adopted without discussion. A long code of rules to govern trackmen was presented by Messrs. H. W. Reed, W. H. Stearns, J. H. K. Burgwin and John Doyle, and was adopted as read.

At the session on Thursday, Nov. 17, a report on "Block Signaling" was read by Mr. W. H. Stearns. The report gave a brief history of block signaling and explained the methods of operation of the principal systems.

A sample of a tie treated by the Wellhouse zinc process, which had been in the track seven years in adobe soil near Las Vegas, N. M., was shown by Mr. J. M. Meade. At present the Santa Fe is using only the Burnettizing process, omitting the supplementary treatment with tannin and glue which is the characteristic of the Wellhouse process. The actual cost of treating a standard tie 8 × 2 ins. × 8 ft. has been from 14 to 16 cts., by the Wellhouse process and 12 cts. by the Burnettizing process. This includes cost of labor in handling the ties and cutting a seat for the rail base inclining the rail toward the inside of the track.

The committee on force required in relaying rails presented in lieu of a report the following letters:

On the division upon which I am employed we pull the spike and throw out the old rails in a string, or without being uncoupled at the joints; adze the ties well and to a good even bearing before laying down the new rails, which are placed in one at a time, carrying them to position with rail tongs; use an expansion shim or grasshopper, having four legs of varying thickness to permit a more accurate adjustment for changing temperature. Adjust the angle bars and bolt all the new rails together as rapidly as they are dropped into place; full spike the rail and spike into the slot of the angle bars at every joint where it can be done.

Our flagmen stay out all day, unless recalled, with instructions to flag all trains. Just before passenger trains are due and after freight and extra trains get within hearing, we close the tracks, using a split switch point, placing the heel of the point rail against the last new rail laid. If in closing up for the night we stop on a tangent or on the low side of a curve, we close with the switch point. If we close on the high side of a curve, we cut a rail. The point rail is carried on a push car, and is kept just ahead of the rail being thrown out of the track and is then always at hand to use in closing.

In relaying steel rail this year we used a force of 47 men, distributed as follows: 2 flagmen, 6 driving spikes, 3 throwing out old rails, 5 adzing ties, 8 carrying rails with tongs, 1 adjusting expansion shims, 1 holding rail against spikes with bar, 6 spiking, 1 drawing spikes for new joints, 12 putting on six-bolt angle bars, 1 adzing ties for new joints.

Upon the piece of track where the work was done, the curves, ranging from 1° to 5° are almost continuous, and over it moved a traffic of 83 trains daily, crowded pretty close together in the morning and late afternoon.

The ties being deeply cut into by the old rail, the labor of drawing the spikes and adzing was much increased, no spikes having been started or drawn before relaying. A rail of heavier pattern was used in relaying and the gage was drawn in ½ in., necessitating the pulling of all the spikes on the inside of the rail, and requiring one additional man. In throwing out the rails with this force we averaged about one mile of track per day complete on both rails, and were not charged with the detention of any passenger trains. No freight trains were held over ten minutes.

The following officers were elected: President, H. W. Reed, S. F. & W. Ry., Waycross, Ga.; Vice-Presidents, W. H. Stearns, C. & N. W. Ry., Chicago, J. B. Moll, C., M. & St. P. Ry., Chicago; Secy. and Treas., J. H. K. Burgwin, G. R. & I. Ry., Grand Rapids, Mich. Member Executive Committee, Robert Black, Manhattan Ry., New York City. It was voted to hold the next annual meeting at Chicago.

## COMING TECHNICAL MEETINGS.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
Nov. 29 to Dec. 2, New York. Secy., F. R. Hutton, 12 W. 31st St.

ASSOCIATION OF CIVIL ENGINEERS OF DALLAS.
Dec. 2. Secy., E. K. Smoot, 909 CommerceSt.

TECHNICAL SOCIETY OF THE PACIFIC COAST.
Dec. 2. Secy., O. Von Geldern, 719 Market St., San Francisco.

NORTHWEST RAILROAD CLUB.
Dec. 3. Union Station, St. Paul.

MONTANA SOCIETY OF CIVIL ENGINEERS.
Dec. 3. Secy., F. D. Jones, Helena.

ENGINEERS' CLUB OF PHILADELPHIA.
Dec. 3. 1122 Girard St. Secy., L. F. Rondinella.

CIVIL ENGINEERS' SOCIETY OF ST. PAUL.
Dec. 5. Secy., C. L. Annan, City Engineer's Office.

NORTHWESTERN SOCIETY OF ENGINEERS.
Dec. 6. Secy., D. W. McMorris, Burke Block, Seattle, Wash.

CIVIL ENGINEERS' CLUB OF CLEVELAND.
Dec. 6. Secy., Chas. S. Howe, Case School.

DENVER SOCIETY OF ENGINEERS AND ARCHITECTS.
Dec. 6. Secy., Geo. H. Angell, 36 Jacobson Block.

ATLANTA SOCIETY OF CIVIL ENGINEERS.
Dec. 6. Secy., Parker N. Black, Capitol Block.

ENGINEERS' SOCIETY OF PHOENIXVILLE.
Dec. 6. Secy., W. Halliburton.

WESTERN SOCIETY OF ENGINEERS.
Dec. 7. Secy., Jno. W. Weston, 51 Lakeside Bldg., Chicago.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
Dec. 7. "Living Reservoirs with Asphalt." Secy., F. Collingwood, 127 East 23d St., New York.

ENGINEERS' CLUB OF ST. LOUIS.
Dec. 7. Secy., Arthur Thacher, Odd Fellows' Building.

ENGINEERS' CLUB OF MINNEAPOLIS.
Dec. 8. Secy., F. W. Cappelen, 1628 Hennepin Ave.

ENGINEERS' AND ARCHITECTS' CLUB OF LOUISVILLE.
Dec. 8. Secy., Edward Mead, Norton Building.

ENGINEERING ASSOCIATION OF THE SOUTH.
Dec. 8. Secy., O. H. Landreth, Nashville, Tenn.

NORTHWESTERN TRACK AND BRIDGE ASSOCIATION.
Dec. 9. Secy., D. W. Meeker, St. Paul.

CANADIAN SOCIETY OF CIVIL ENGINEERS.
Dec. 9. Secy., C. H. McLeod, Montreal, P. Q.

# ENGINEERING NEWS
AND
AMERICAN RAILWAY JOURNAL.

*Published Weekly at Tribune Building, New York. Entered at the Post Office, New York City, as Second Class Matter.*

VOL. XXVIII. THURSDAY, DECEMBER 1, 1892.

D. McN. STAUFFER, A. M. WELLINGTON.....EDITORS
CHAS. W. BAKER, E. E. R. TRATMAN, M. N. BAKER, F. P. BURT, } ASSOCIATE EDITORS
GEO. H. FROST.....BUSINESS MANAGER

*SUBSCRIPTION RATES: One year, $5.00; 6 months, $2.50; 4 months, $2.00; single copies 15 cents. To all foreign countries in the Postal Union, add $2.08 to above prices for postage. Subscribers can have the mailing address of their paper changed as often as they desire. They should send both the old and the new addresses. No club rates are allowed.*

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*ADVERTISING RATES: 20 cents per line agate measure. Schedule sent on request. Changes of advertisements must be in hand on Monday afternoon; new advertisements, Tuesday afternoon; transient advertisements, not later than Wednesday noon. The last pages go to press early on Thursday. We shall be obliged if subscribers who fail to receive their papers promptly will notify us without delay.*


The recent fire test of a fireproof building at Chicago, is a most valuable lesson to engineers and contractors engaged on this class of work, as well as to the manufacturers of the fire proofing material used for covering the metal columns and beams of the skeleton framing of these steel buildings. The fire was a hot one, but very little injury was done to the steel structural work of the building, except where the fireproofing had not yet been put on, or where it had been put on in so faulty a manner that its fastenings burned away, allowing the fireproof covering to fall off. The owners of the building were wise in having the structure examined by experienced engineers, and in another column we give the engineers' report and notes, showing clearly the effect of the fire. The report also shows the very high degree of safety of such a building when properly constructed. When fireproof material is used to protect any part of a building it is of the utmost importance that it should be so secured that it cannot be burned off, or easily knocked off by any light falling material. One view of the case is that the fireproofing in this case was ruined by water being unnecessarily poured on it when thoroughly heated and when the fire had already done all the damage possible. This is scarcely a fair view, however, as if properly put on this fireproofing would have been secure, and in any case the first duty of the firemen is to put out a fire and prevent it from spreading, and they cannot and should not be expected to stop and find out whether the fire has completed its work before they begin to try and extinguish it. There might have been persons in the building and it was far better to risk damage to the structure than to risk human life. In future work of this kind the absolute necessity of so securing the fireproofing material that it will stay in place and fulfill its purpose when subjected to test should be recognized and insisted upon very strongly.

The Panama Canal case is now brought before the French courts after all, and despite the great influence exerted over the French Government by those who are said to have benefited by their connection with the canal. Notwithstanding the fact that official procedure of more than a year ago brought to light material sufficient to condemn the promoters of this scheme, nothing was done, and until a few weeks ago it was generally believed that all connected with this bankrupt company would escape investigation. But now the Minister of Justice has taken the matter in hand, has exhibited the collected evidence to the Cabinet and threatens to resign unless a vigorous prosecution is ordered by the State. The Prime Minister and his backers only yielded after a sharp fight to this call for justice from a prominent member of the Cabinet.

It is claimed by those who are in a position to know that out of the $290,000,000 of cash obtained by the sale of Panama stocks and bonds only about one-third of this amount was actually expended on canal work, and this third was most wastefully spent. The obligations of the company amount to $425,000,000, and for this enormous sum of money the bankrupt company can only show piles of rusting and practically worthless machinery, useless hospitals, empty workshops, some miles of railway and villages of workmen's houses, the majority of which were never occupied but upon which favorites of the company collected their 20% for construction. The canal work done has long since been practically undone by the floods of the Chagres River. All that is left is a magnificent ruin, and a monumental instance of careless engineering, and of "jobbery," that is also magnificent in its proportions, if all that is said be true.

In a personal visit to the Isthmus, about two years ago, our ears were filled with stories of individual cases of fraud which were recited at the time, and enough was seen to prove gross carelessness and a reckless waste of money, if nothing more, on the part of the canal company. Side tracks were filled with machinery, bought and paid for through agents, and yet never used for the good reason that it was totally unfit for the purpose intended. Hospitals that cost millions, magnificent houses for officers of the company and drives built for the sole use of the canal officers, along with evidently misdirected engineering effort, attest the truthfulness of some of the charges now made in France. If the French Minister of Justice is successful in his present effort to get at the true inwardness of Panama Canal management, the world may see exposed a case of official rottenness and fraud unequalled in its history.

Sanitary science, with sanitary engineering as one of its most important divisions, is to be made a prominent feature at the World's Columbian Exposition, a Bureau of Hygiene and Sanitation having been organized under the Department of Liberal Arts. This bureau has for its object the presentation of exhibits illustrative of the development and progress of sanitary science in all matters pertaining to the public health. As shown by the description and classification published in another column, the work of the bureau and the scope of the exhibits are very comprehensive, and if properly carried out should have an excellent educational effect in promoting the advancement of proper sanitation and the general improvement of sanitary methods. Sanitary engineering is a branch of the profession which is growing in extent and importance, and to which many prominent engineers have already turned their attention as a specialty. We need hardly say that we deem it a very important department, as our columns will bear witness. It will be seen by the classification that the exhibits and work of this bureau will be of general interest to engineers (particularly those engaged in municipal and sanitary work), health officers and boards, boards of public works, etc., and to city and State boards and committees having charge of public improvements and statistics. Contractors and manufacturers will also find much to interest and instruct them. There is in this country an enormous field for improvement in matters relating to public health, not only in the larger problems of water supply and sewage disposal for communities, but in the smaller, though hardly less important, matters of plumbing, ventilation, etc., which have their bearing upon individuals. The Bureau aims to show the present position of the theory and practice of hygiene and sanitation in all their branches, as well as to compare and display the difference between proper and improper methods and materials. Public protective supervision, as exercised in the care and inspection of immigrants, the treatment of cases of infectious diseases, quarantine arrangements, food inspection, building and fire regulations, etc., will also be included. A large and systematic collection of charts and diagrams of health, mortality, rainfall and other public statistics is also contemplated, and it is proposed to form a library of reports and other publications dealing with sanitary matters and public health. The work of the Bureau is intended to include exhibits, etc., from foreign countries, and the Bureau desires to co-operate with and receive suggestions or recommendations from experts in any of the branches of sanitary science, as well as from sanitary societies and public officers.

## THE LINE AND STAFF OF THE NAVY.

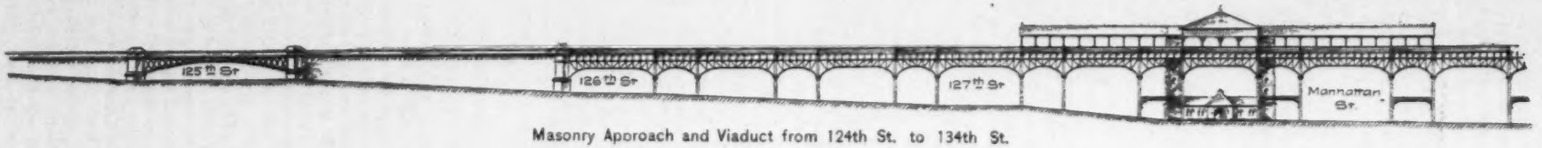
The court-martial of Assistant Engineer Danforth, which has attracted so much attention lately as in effect a test case of the relations of line and staff, has been settled by Secretary Tracy in favor of the line. He has approved the finding of the court that Danforth was guilty of disobedience of orders in refusing to leave his post in charge of the engine-room and of certain tests at the command of the officer of the deck; and, besides approving sentence of one year's suspension on half pay, he is reported to have said further that but for the youth and inexperience of the accused he would have ordered the court to impose a still more severe sentence.

The effect of this decision, if logically extended, is to place the medical and pay staff also under the absolute orders of the officer of the deck, as fully as he is admittedly under the orders of the captain or executive officer. That every person on board ship is bound at once and implicitly to obey any order of the captain or executive officer at the peril of arrest is, we believe, established naval law. By this decision the same absolute authority is extended to the officer of the deck. It is alleged with much probability, that an effort will be made to secure a modification of the force of this decision by Congressional action.

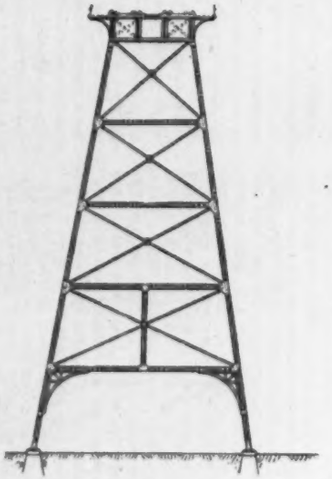
What the modification should be, if any, is most difficult to see by anyone who looks at the subject impartially. We can see much force in the position of both sides. On behalf of the line it is claimed with much force that the officer of the deck is, as much as the executive officer, the representative of the captain, and to permit any person on board to disobey or neglect his orders, for whatever reason given, would be to introduce a disorganized tendency which might be perilous in an emergency. We can see, for instance, why it should be a dangerous precedent to permit any engineer officer to disobey a positive order from the officer who is for the time being in command of the ship and responsible for its safety, as Danforth did in ignoring a command from the officer of the deck.

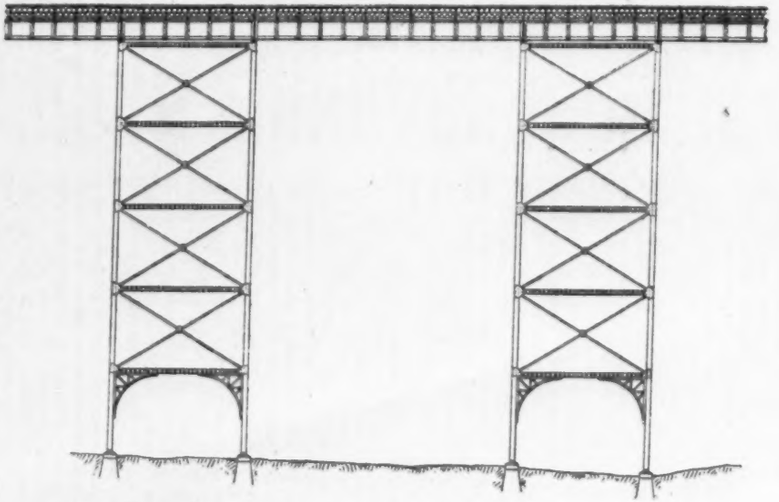
But are there not equal or greater dangers on the other side, and was not this officer of the deck still more at fault than Danforth, and still more deserving of punishment by court-martial? He was in reason, whether he is by naval law or not. His conduct was "prejudicial to good order and discipline" in several ways. In the first place, he sent an order to one of the engineer force on duty, not through the engineer officer on watch, but directly to the man over his head, and without even informing the officer on watch of his action. It was from this act that all the rest followed. If a line officer has the power to do an act like this without penalty under present regulations, it is certainly an abuse which should be at once checked by legislation or otherwise. It is not only contrary to all sound principles of discipline, which require that such orders from a superior officer shall be transmitted through the officer in immediate charge, if on the spot, but it may at any time involve grave special perils to the ship.

The truth is, and it cannot be too soon recognized in regulations for the good of the service, that since steam has come to be not only the sole means of propelling the ship, but the sole or chief means of lighting, heating, cooking and maneuvering the ship and armament as well, an "imperium in imperio" necessarily exists on every ship, and must be recognized as such or the service will suffer, whether in the navy or commercial marine. Just as the order of the captain or his temporary representative must in the last resort be supreme (and this seems to us a necessity) because emergencies on deck may exist which an officer below cannot judge of, and cannot be permitted to attempt to judge of, if it comes to a conflict of authority, so emergencies may exist below in the management of the engines (and are far more likely to do so) which no line officer on the ship can adequately

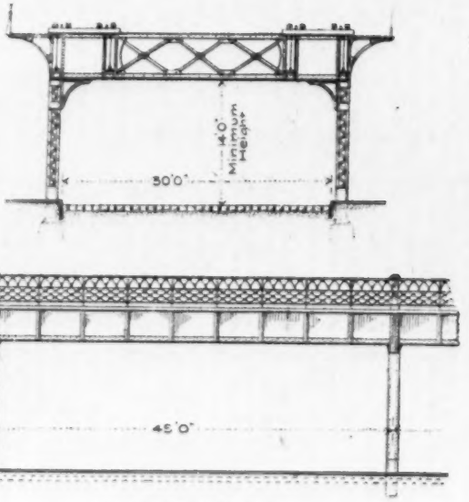



Masonry Aproach and Viaduct from 124th St. to 134th St.
(Scale, 110 ft. to 1 in.)

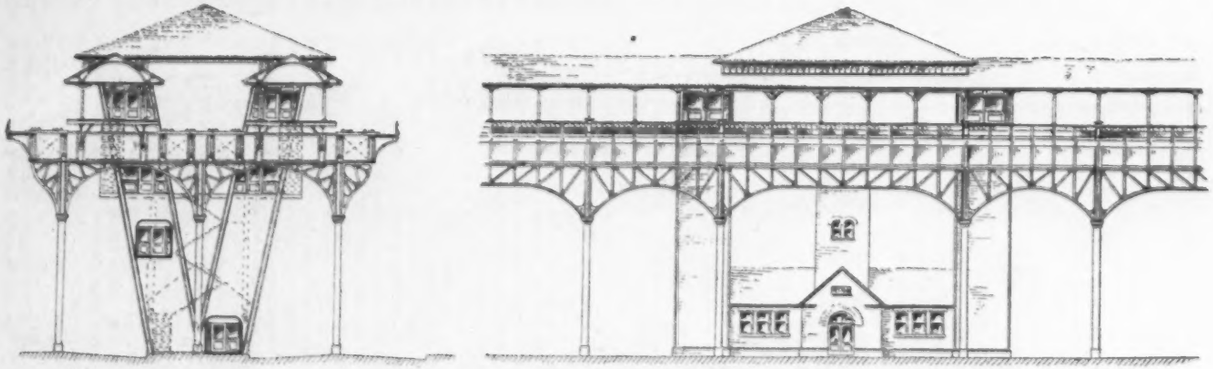




Sherman Creek Viaduct.
(Scale, 35 ft. to 1 in.)




Double Track Viaduct.
(Scale, 17.5 ft. to 1 in.)



Station at Boulevard and Manhattan St.
(Scale, 35 ft. to 1 in.)

DESIGNS FOR STRUCTURES

ON THE

NEW YORK RAPID TRANSIT RAILROAD.

John Bogart,
Chief Engineer.

W. B. Parsons,
Deputy Chief Engineer.

judge of, and hence he should be held by regulations to a very strict responsibility for any abuse or unnecessary use of his authority. To this end it seems to us plainly necessary that except in action or time of peril no line officer, not even the captain, should be permitted by regulations to issue any order to the engineer force or any member of it, except through the chief engineer or his representative on duty. If, however, he does issue it, for whatever reasons satisfactory to himself, it does not seem to us permissible that any staff officer should be permitted to disobey. He should obey, but he should have his remedy against repetitions of any needless interference by strict regulations limiting the power of the line over the personnel of a service which they do not understand, and are not fitted by their general or special knowledge to interfere with arbitrarily.

To this complexion it will come at last, line officers may be well assured. It has already come about in the merchant marine. Formerly the chief engineer was as much under the immediate orders of the captain as any sailor. If he wanted to use him he sent his boy for him. Of late years, the chief engineer has become so much more important an officer than even the captain to the success of a crack liner that, though the captain still has as great reserve power as ever, he does not venture to exercise it on ordinary occasions. He recognizes that the chief engineer is much less likely to be a free agent than himself during a voyage, and if he wishes to see him, is much more likely to send to inquire when it will be convenient.

We may not expect as great a change as this in the naval service, nor is it proper or desirable. But we may expect, and shall most certainly see, the chief engineer placed in a position of greater authority than now in respect to interference of junior line officers with his staff, and in a relation to the captain more closely corresponding to that of the commander of a ship to an admiral of the fleet. It may come slowly, since the precedents of centuries will not yield at once to new conditions, but come it will, and greatly to the good of both branches of the service. The friction which is now so conspicuous will then cease.

From this point of view the chief fault to be found with the Danforth findings is not that they were unfair in themselves, so far as they went, but that they did not go far enough. Danforth offended against discipline only, and is severely punished for it. The young line officer whom he refused to obey not only offended against established principles of discipline, but against reason and propriety as well, in ordering a fireman on duty to leave his post and report on deck without transmitting the order through the engineer on watch; and yet he is not punished at all. Both should have been punished or neither, in reason and justice, if not under naval regulations.

## AN ENGINEERING CODE OF ETHICS.

In discussing "The Ethics of Consulting Practice" in our issue of Nov. 10 we took occasion to point out at some length the need for establishing in a formal way (for we hold them to be already established in their substance in an informal way) certain elementary rules of good manners and fair dealing between engineers, which should make it impossible for one engineer to deal unfairly with another in these specified relations without running the risk of being excluded from good standing in the profession. The editor of a professional organ like this is in the way of hearing of many cases showing the need of such a rule which do not become generally known, and we have heard of many such. One such of no little importance is already before a large section of the profession in a quiet way, and perhaps may yet come before the whole of it in a public way. But as a rule, it is impossible to discuss specific instances publicly, without running a risk of injustice to individuals from partial knowledge of the facts, which no journal likes to take. And as the only way in which a strong general sentiment on any such subject ever springs up is by general knowledge of specific instances where wrong was done, it is only by the slow and gradual growth of conviction that such needed reforms are effected.

Believing and knowing as we do, however, that there is urgent need of such reform, to the extent of establishing a few elementary rules of professional good manners and courtesy, at least, we shall continue to do what we may in an impersonal way to create a sentiment in favor of so doing, as one of the greatest services which we can render to the profession.

As one means to this end, we reprint below in full some remarks of the "American Architect" on the subject, showing what the members of a profession which is somewhat better off than we are in this respect, think of our present status:

> The Engineering News has done the profession of engineering a service in proposing that a short and simple code of ethics, similar to that in use, for example, in the medical profession, should be drawn up, and, as soon as may be, adopted. It does not, of course, expect the immediate acceptance of a set of rules, but, as it truly says, a code of professional ethics is nothing more than the definite statement of the principles by which honorable members of the profession are already guided; and its value is to be found, not in the novelty of the duties which it imposes, but in the standard which it sets up for guiding, and perhaps for criticising, the conduct of persons who either have little experience in professional life, or who may be unable otherwise to resist the temptation to profit by actions which, although of questionable propriety, have not been specifically condemned by the profession, and so do not involve any loss of professional standing, if violated.
>
> The first rule which it proposes is as follows:
>
> "I. It shall be considered unprofessional and dishonorable for any engineer to accept a call in consultation for any work which is already in charge of an engineer, except the call come from or through such engineer in charge. Engagements tendered from principals shoul be considered or accepted only when there is no engineer already in charge of the work.
>
> We wish we had space enough to quote at length the admirable arguments with which it supports this proposition, but all architects will appreciate the substance of them, which is that, as the calling-in of a consulting expert implies a doubt whether the engineer in charge has done, or will do, the best possible thing for his client, it is due to him that he should have the opportunity to explain his operations to the brother engineer who has been called in to criticise them. If the engineer in charge refuses, at the request of his employers, to call in an expert, his employers are at liberty, if they see fit, to oblige him either to accede to their wishes or resign, and leave them free to do what they think necessary; but, as the Engineering News observes, such pressure should come from the employer, not from a fellow-engineer. The second rule proposed runs thus:
>
> "II. It should be considered unprofessional and dishonorable for any engineer to report upon any work which is already in charge of an engineer, except to such engineer in charge. Reports to principals direct should only be made when there is no engineer in charge; nor then when there has been an engineer in charge whose professional acts are impeached in such report, without prior tender of a copy of such parts of the report as may personally concern him for his perusal and response."
>
> The purpose of both these rules is the same—to prevent men who have probably done their duty with fidelity and skill from being grossly injured, behind their backs, by their fellow professional men, to whom they should have a right to look for appreciation of their work; but we need hardly point out that the observance of them is quite as much for the advantage of the consulting expert as of the professional man in charge. A physician, called in consultation, who should pronounce judgment on the case without learning all that he could about the symptoms and the treatment from the medical man regularly in charge, would be rated as an ignorant quack, and there is no engineer or architect whose opinion on a work in progress would not be rendered more valuable by consultation with the expert who had been connected with it from the beginning, even though that opinion might be extremely unfavorable to the system according to which the work had been carried on. To learn a man's reasons for doing a thing in a certain way involves no necessary approval of the way in which he has done it, although it is likely to modify very materially a hasty unfavorable judgment; but if the judgment, after the reasons have been heard, must continue to be unfavorable, it gains ten-fold authority from having been prepared with full knowledge of all the circumstances. As the Engineering News says, unless the consulting expert "knows at first hands what the engineer's plans and motives were and are . . . he cannot be sure of doing justice either to himself, or his employer, or to his fellow-engineer, and certainly not to all three," and most architects can recall instances where a consulting expert has made himself extremely ridiculous in the eyes even of his employers, by pronouncing judgment upon matters in regard to which he had not been honorable enough to inform himself by application to the person who could have given him the facts required as a basis for an intelligent opinion. It may be imagined that a blunder of this sort does not help a consulting engineer's reputation among owners, most of whom go to experts to get the best information possible, leaving to them the means of obtaining it, while the small minority, who call in experts simply as catspaws to help them to play some dirty trick upon a man to whom they are already under obligation, and whom they dare not meddle with unaided, are still less likely to be grateful for a collapse of their plans brought about in such a way.

What specific steps, if any, should be taken by engineers to establish these two rules and two or three others like them, we are not at present prepared to suggest. This at least is certain. Like any other code of good manners (for a "code of ethics" is nothing but that) it should not be established in too formal a way, as if nothing but the terrors of the law would lead the majority to respect it. To do so would cast an undeserved reproach on the profession as a body, an overwhelming majority of which respects the spirit of such rules instinctively, code or no code; and an even half of which, perhaps, respects the letter also, code or no code, from an instinctive sense of courtesy and equity.

But the formal action, if any, should go far enough to make it impossible for any engineer to plead ignorance of the practice of the profession as an excuse for such bad conduct; far enough, for example, to warrant the professors of our engineering schools in teaching the rising generation of engineers: "Such are the recognized rules of the profession; it will be perilous to violate them:" far enough to warrant and compel the national engineering societies to punish violations of them by expulsion. The cases of such flagrant offense as to warrant so severe a penalty as expulsion are even now very rare. But we believe and know that the cases of mere professional bad manners, or neglect of the forms of courtesy, are very common; so common as to affect most injuriously the morale of the profession and its standing as a body before the public; just as any other kind of boorish bad manners which might prevail among any body of men would tend to lower the respect in which the public held them, though they might be morally beyond reproach.

Violation of either of the rules which we have suggested, as above quoted, is at the best and in every case precisely that, boorish bad manners, even when it is nothing else and worse. As we said in our former article: "If engineers do not respect each other, who shall respect them?" Certainly not those who buy them for a price to humiliate their fellow engineer discourteously, whether the humiliation be deserved or undeserved. They will rather the more despise them.

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This season's traffic through the Sault Ste. Marie Canal exceeds by 20% the tonnage of any previous year. In October alone, 1,135 steamers, 395 sailing vessels and 71 rafts passed through the Sault. The aggregate tonnage was 1,432,533, or 28,000 tons more than in October, 1891. The total for this year will reach nearly 11,000,000 tons, as compared with 9,000,000 tons for the best previous season. Shipbuilding is keeping pace with this lake traffic, and ships to the value of $7,000,000, with a carrying capacity of 68,000 tons, are now under contract in lake shipyards, says the Cleveland correspondent of the New York "Tribune." Two steel ships to cost $500,000 each are now building at Cleveland, O. They will be 380 ft. long, 44 ft. beam, and have a speed of 20 miles per hour, and will run between Buffalo and Duluth in 50 hours. The late loss of the "Western Reserve" and the "Gilcher" has attracted attention to the weak upper hulls of some of these lake steamers and there is a movement toward improvement in this direction. These lake steamers have unusually heavy bottoms so as to stand the strain of traffic and rapid loading and unloading. It is not an unusual thing at the Escanaba docks to unload an ore pocket of 125 tons into one hatch in 5 minutes. During the present summer the "Manhattan" loaded 2,010 tons of ore in 45 minutes; the "Kaliyuga," 2,120 tons in 60 minutes; and the "Maritana" took on 4,218 tons of ore in barely 3½ hours, and the "Maryland" has been known to load 3,027 tons in 3 hours. As the loading is done through 7 or 8 hatches at a time this rapid work is not so dangerous as the slower loading by single hatches. These ships are also severely strained at times by careless unloading. The newer boats planned are to have their upper decks, heretofore weakened by the numerous hatches, made as stanch as the bottom has long been. The sides, too, are to be made much stronger, giving the ship greater value as a beam when in rough water.

## LETTERS TO THE EDITOR.

### PROTECTION OF IRRIGATION EMBANKMENTS.

Sir: In your issue of Nov. 10, under the heading "Irrigation Canals in India," mention is made of embankments "protected with stone on the principle advocated by Mr. J. R. Bell." Will you kindly let me know where a description of Mr. Bell's method may be found, or, better still, give a short description in your columns. J. L. Allison.

Coteau Landing, Que., Nov. 19, 1892.

(We are not familiar with the details of Mr. Bell's system, alluded to in the report, and shall be glad if any of our readers can furnish particulars.—Ed.)

### COST OF LAYING PIPE SEWERS AT DALLAS, TEX.

Sir: In Engineering News of Nov. 17 you have a table on page 466 which I sent you recently. I find the depths for excavation and backfilling are incorrectly printed, as follows:

| As printed. | Should be. |
|---|---|
| 6 ft. deep. | 6 ft. deep. |
| 7 to 8 " | 6 to 8 " |
| 9 " 10 " | 8 " 10 " |
| 11 " 12 " | 10 " 12 " |
| 13 " 15 " | 12 " 15 " |
| 16 " 18 " | 15 " 18 " |
| 19 " 21 " | 18 " 21 " |
| 22 " 25 " | 21 " 25 " |

Under the above, the specifications in use here have been interpreted to pay the same amount for a depth of 6.1 ft. as for 7.9 ft., or the same for 8.1 ft. as for 9.9 ft., etc., making the points of division as shown above. Frank E. Snyder.

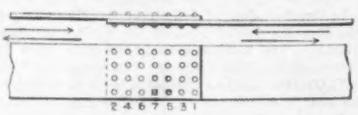
Dallas, Tex., Nov. 21, 1892.

### CONCERNING RIVET VALUES.

Sir: Will you kindly inform me through your valuable paper if some experiments, on a large scale, were ever made on riveted connections in metallic bridges and buildings. In calculating the number of rivets for a connection, we have so far given to each one the same share of work, knowing quite well that this theory is not true. Experiments on soft materials have shown me that the first and last rows of rivets in any connection take the greatest amount of work, and that both rows work equally. The second row is brought into action by the elasticity of the material; so is the third one; but the work done by the second and third rows is smaller than the work done by the first one.

In referring to the sketch herewith, I mean that rows 1 and 2 work equally; so is 3 and 4, 5 and 6; the forces being indicated by arrows—tension or compression. I believe that in riveted connections, the amount of work taken by any row of rivets decreases gradually from each end toward the center. Consequently, if there is a row of rivets in the center of a connection, as row 7 in above sketch, that row is idle.

It is the most favorable way of looking into the riveted connection, and I would not be surprised at all to find, some day, that the first and last rows do some work, and that the amount done by the others is




practically nothing. This might seem odd, but it would only confirm what a number of French authors have advanced, viz., in carefully riveted connection, we must to a great extent rely on friction.

My aim in writing to you is to know if any experiments were ever made in view of getting the share of work for each row of rivets in a given connection. Should some of your readers express an opinion on the subject, I would be very glad to enlighten myself by paying attention to it. Yours sincerely,

Avila Gravelle, C. E.

Pencoyd, Pa., Oct. 31, 1892.

(We do not know of any experiments in the exact line of our correspondent's query; and we consequently publish his letter for enlightenment from without.—Ed. Eng. News.)

### NOTES AND QUERIES.

Questions in surveying have been received from "A Subscriber," Hampton, Ia., and from "X," Superior, Wis.

Notes on magnetic variation will be found in Hodgman's "Manual of Land Surveying," p. 26, or Johnson's "Theory and Practice of Surveying," p. 21. The proper way to lay out the fractional quarter sections in a township is described on p. 194 and p. 184, respectively, of the same works.

"X" will see by reading p. 280 et seq. of Hodgman's manual, and p. 174 et seq. of Johnson's surveying, that the monuments set and marks made in the original survey of a section line will govern, no matter how crooked the line joining these proved points may be.

E. H., St. Louis, Mo., asks: In what manner and in what combination is tribasic sodium phosphate ($Na_3PO_4 + 12H_2O$) used for removing and preventing boiler incrustations? What is the market price and where can it be bought in large lots—say 10 bbls., at a time?

H., of Tacoma, Wash., asks information concerning the details of any nozzle approaching 12 ins. in diameter, or if nozzles of this size have ever been used. The Monitor 5½-in. nozzle used on the later New York fireboats is the largest we have any knowledge of, but we would be pleased to hear from anyone having further information.

## THE ENGINEERING SCHOOLS OF THE UNITED STATES.
## XXXIV.

### Distribution of Time to the Several Studies.

The accompanying Tables XXXIII. and XXXIV. relate to the most important feature of the present inquiry, so far as the quality of the instruction given is concerned, unless the several requirements for admission (which have been already given) may be an exception. Given common requirements of admission, it is a matter of judgment on which men may differ how the time of the course may be best distributed, and as the ideally "best" distribution would differ more or less for each student, there can be no absolute test.

Between the nominal and real requirements for admission, however, there may be a vast difference, and therefore the best criterion as to the actual standard for admission is given by the amount of time devoted after admission to the more elementary studies, as for instance to elementary mathematics. Even this is far from a perfect standard, for every professor knows it to be an open question whether a more perfect working mastery of the elementary studies would not be a greater real gain to the student than to be hurried superficially over a wider range of studies. If, therefore, we find a school of known high standing and merit devoting a good deal of time to elementary studies we may reasonably conclude that it does it from this motive, which in our judgment would be a sound one for most of our colleges to act on. On the other hand, there is no doubt that some of the weaker colleges rush ill-prepared students over a superficially broad curriculum for appearance sake, with the necessary result that the knowledge thus given has very little depth or solid volume, and hence is almost worse than none. Still, in a general way, the distribution of time does enable one to form a pretty correct idea of what the several schools really are, if accurately known. We wish we could say that it can in every case be known from the face of these tables, but unfortunately we cannot. For reasons which we have heretofore explained (chiefly the great difference of student's time represented by a class room hour and by a laboratory or field-work hour) the face of our returns differ greatly from the several colleges. They are given as a matter of record in Table XXXIII., precisely as returned.

The extreme error which has resulted from this inclusion of different classes of "hours" as if each meant the same amount of time and work is illustrated by Nos. 14, 15 and 18 in Tables XXXIII and XXXIV., where we were able to give a double return, the first line being for "hours" just as they are on the college schedule, each class hour meaning two to three hours of student work, while the laboratory, field or shop hours mean only their face value of student work; the second line giving the hours of all kinds on the equated basis of the class-room hour, i. e. each representing from 2½ to 3 hours of actual student work.

The difference is not so considerable as might be expected, but it is considerable. That there should be such a discrepancy is largely our own fault. We frankly admit it. We did not duly appreciate the confusion which might result from this course, or we should have given more specific instructions about the mode of making this return. Neither did the professors on whom we relied for advice as to this matter, evidently, or they would have advised differently.

Be this as it may, the more general table deduced from Table XXXIII. (Table XXXIV.) ought to give a pretty accurate idea of the comparative absolute and relative time devoted to the five general classes of studies detailed at the head of the main table. It gives the total number of complete weeks devoted to each class of studies in the several colleges and was deduced from the larger table as follows:

Knowing the number of weeks in each undergraduate college course, and the total number of "hours" reported, dividing one by the other gives the mean number of hours per week covered by the report of each college; and dividing the number of hours per week by the number of hours reported for each class of studies, gives the number of weeks devoted to that study, subject to the cause of fractional error noted, which tends to make the time devoted to mathematics and other purely classroom studies appear less proportionately than it really is, and the time devoted to chemistry, surveying, etc. appear more important than it really is.

TABLE XXXIV.—Weeks of Entire Course of the Several Colleges Devoted to the Several Classes of Studies as Below Noted:

| | A. | B. | C. | D. | E. | Total. |
|---|---|---|---|---|---|---|
| 1. R. P. I. | 20 | 28 | 30 | 33 | 49 | 160 |
| 2. Harvard | 8 | 28 | 47 | 34 | 35 | 152 |
| 3. Yale | 11 | 23 | 34 | 8 | 38 | 114 |
| 5. Union | 16 | 30 | 44 | 14 | 48 | 152 |
| 6. U. Mich. | 13 | 51 | 23 | 28 | 49 | 144 |
| 8. Pa. M. A. | 30 | 20 | 35 | 17 | 38 | 140 |
| 9. Columb. | 6 | 13 | 15 | 37 | 57 | 128 |
| 10. Wash. and L. | 31 | 42 | 22 | 26 | 35 | 156 |
| 11. M. I. M. | 19 | 18 | 23 | 21 | 64 | 136 |
| 12. Lehi. | 15 | 20 | 40 | 31 | 46 | 152 |
| 13. U. Va. | 24 | 20 | 22 | 17 | 34 | 117 |
| 14. Cornell C. | 13 | 21 | 18 | 23 | 85 | 160 |
| 14. Cornell C. | 15 | 24 | 24 | 22 | 75 | 160 |
| 15. Tufts. | 16 | 14 | 9 | 21 | 44 | 114 |
| 15. Tufts. | 20 | 23 | 11 | 21 | 39 | 114 |
| 16. U. Ga. | 32 | 35 | 19 | 34 | 24 | 144 |
| 18. Wash. U. | 21 | 38 | 23 | 43 | 75 | 200 |
| 19. U. Vt. | 27 | 31 | 28 | 26 | 40 | 152 |
| 21. W. P. I. | 12 | 18 | 22 | 41 | 40 | 133 |
| 22. Ala. P. I. | 21 | 20 | 36 | 10 | 65 | 152 |
| 24. Ia. A. C. | 17 | 18 | 23 | 15 | 59 | 132 |
| 25. U. Pa. | 13 | 24 | 64 | 25 | 34 | 160 |
| 26. Stevens | 13 | 25 | 24 | 20 | 78 | 160 |
| 27. U. Wis. | 21 | 27 | 26 | 22 | 52 | 148 |
| 28. Thayer | 8 | 1 | 16 | 41 | 66 | |
| 29. Swarth. | 20 | 23 | 38 | 37 | 30 | 148 |
| 30. Cornell M. | 17 | 51 | 5 | 17 | 70 | 160 |
| 32. U. Cal. | 16 | 18 | 32 | 41 | 39 | 146 |
| 33. U. Kans. | 13 | 20 | 18 | 24 | 57 | 132 |
| 34. U. Min. | 10 | 14 | 26 | 26 | 72 | 148 |
| 37. C. Coll. Ia. | 12 | 18 | 37 | 36 | 41 | 144 |
| 38. U. Ill. | 17 | 24 | 29 | 38 | 36 | 144 |
| 41. Tex. A. C. | 23 | 11 | 28 | 32 | 62 | 156 |
| 52. U. Neb. | 21 | 38 | 25 | 18 | 40 | 142 |
| 43. Col S. M. | 19 | 28 | 21 | 40 | 44 | 152 |
| 46. Purdue | 28 | 31 | 20 | 19 | 54 | 152 |
| 47. Rose P. I. | 17 | 43 | 7 | 19 | 62 | 148 |
| 48. U. Tex. | 15 | 29 | 40 | 13 | 43 | 140 |
| 49. M. M. S. | 7 | 14 | 24 | 38 | 52 | 135 |
| 50. Mich. A. C. | 30 | 39 | 25 | 14 | 36 | 144 |
| 52. Mont. S. M. | 14 | 20 | 47 | 34 | 45 | 160 |

The studies included within each class are given in detail in the headings to Table XXXIII. The classes themselves (also there given) are as follows:

A. Elementary mathematics.
B. Advanced mathematics.
C. Collateral adjuncts.
D. Minor technicals.
E. Advanced technicals.

All the courses here given are for civil engineering, except Nos. 26 and 30, which are mechanical, and Nos. 43, 49 and 52, which are mining, all as explained below Table XXXIII.

THIS TABLE WILL BE SHOWN GRAPHICALLY IN A DIAGRAM after two weeks' interval to admit of correction.

COLLEGES LISTED above are invited to send in at once CORRECTIONS of the distribution of time in weeks, as above, if not materially correct, that their college may not be misrepresented.

COLLEGES NOT LISTED are invited to send in the distribution of their curriculum to the several studies in weeks of entire course, that they also may be represented in the diagram and table.

We deem the indications of Table XXXIV. so important and interesting that we propose to show them graphically, and in order to give every college opportunity to be represented with perfect fairness in this diagram, we invite every college to check the figures given for it in Table XXXIV. (which can be done very quickly) and send in to us the correct figures for the actual distribution of student time, if those given for it are not correct. If such corrections reach us on or before Dec. 12, they will be used in constructing the diagram for that college instead of the figures we give.

Similarly we invite every engineering school which may not be represented in Table XXXIV. to send us the correct figures for it corresponding

to those given in the table. All such additions received on or before Dec. 12 will be included in the diagram and table.

Pending the receipt of these corrections and additions, and the preparation of the diagram referred to, we refrain from all comment on the tabular information here given.

We earnestly request every college to take pains to see that it is represented, and properly represented in this diagram, while there is yet time to do so.

MEMBERSHIP OF AM. SOC. C. E. FROM RENSSELAER AND THE MASS. INST. TECH.

Sir: In a letter to Engineering News, dated Nov. 5, and published in your issue of Nov. 17, 1892, I deduced the following table by a comparison of the Associate Members who are C. E. graduates of these institutions be included, the table becomes:

| Name of school. | Number admitted as corporate members. | No. of C. E. graduates 1860-84, inclusive. | Per cent. corporate members Am. Soc. C. E. |
|---|---|---|---|
| R. P. I. | 153 | 460 | 33.3 |
| M. I. T. | 29 | 109 | 26.6 |

In the tables in your article on the Engineering Schools of the United States, published in your issue of Nov. 17, you divide 42 by 100 to get your 38.6% for the M. I. T. There are 34 graduates of that school who are M. Am. Soc. C. E. and A. M. Am. Soc. C. E., that is, corporate members. The records of the society show this number to date. These graduates come from four different courses, the civil engineering, the mining engineering, the mechanical engineering and the course called general studies. If your number, 42, in your table on page 471, is correct, you must have included 8 non-graduates, that is, you have taken the corporate members who have graduated in four different courses, added 23.5% of non-graduates, and divided by the number of C. E. graduates only, to get your percentage. The figures relating to the R. P. I., given in this letter, are for C. E. graduates only, and non-graduates are not considered. There is no accurate method of getting at the non-graduate members, and I cannot see why they should be considered in a comparison of this character. If you divided the 34 by 250, the number of graduates in the four courses referred to above, you would get 13.2%.

It is true that the older institutions have an advantage referred to by you in your comparison, but such advantage, as far as this institution, which gives only one engineering degree, is concerned, is, in my opinion, more than balanced by the consideration that when a school gives several courses, the students choose the course in which the branch of engineering which they will probably afterward pursue, is taught, whereas in a school giving a broader and more general engineering education, the students after graduating choose any of the engineering branches, or perhaps, none of them. As a matter of fact, a casual inspection of our catalogue will show that many of our graduates become mechanical or electrical engineers, and a large percentage of them pursue vocations which render them ineligible for corporate membership in the Am. Soc. C. E. A general consideration of the occupations of our graduates leads me to the conclusion that about 60% of them only become eligible for corporate membership.

Nor can I agree with you that the R. P. I. has an advantage, as far as membership in the society is concerned, from the fact that it is situated in the state of New York. Troy is about as far from New York as Boston, and, as a matter of fact, the last list of members of the society (1891), shows that 50% of the C. E. graduates of the M. I. T., and only 31% of the C. E. graduates of the R. P. I., who are now M. Am. Soc. C. E. live in the states of New York and Massachusetts. I have not the data at hand to give me the percentages to date. The records of the society to date show that the number of graduates of the R. P. I. who have become connected with it, is as follows:

| | |
|---|---|
| M. Am. Soc. C. E. | 146 |
| A. M. Am. Soc. C. E. | 10 |
| Assoc. Am. Soc. C. E. | 6 |
| Jun. Am. Soc. C. E. | 28 |
| Total number | 190 |

I conclude this letter, as I did my former one, by saying that no invidious comparison with a school of which I have a high opinion is intended. Nor is this meant to be a criticism of the articles on engineering education, in which I have been so much interested, and which are plainly valuable contributions to engineering education; but, while admitting that such a comparison is attended with difficulty from almost any catalogues of the Massachusetts Institute of Technology and the Rensselaer Polytechnic Institute with the last published list of members (1891) of the American Society of Civil Engineers:

| Name of school. | Number admitted as M. Am. Soc. C. E. | No. of C. E. graduates 1860-84, inclusive. | Per cent. now M. Am. Soc. C. E. |
|---|---|---|---|
| R. P. I. | 120 | 460 | 26.0 |
| M. I. T. | 22 | 110 | 20.0 |

Since then I have determined from the records of the American Society the number of graduates of each of these schools who have become members of the society to date (Nov. 25). The table brought to date becomes:

| Name of school. | Number admitted as M. Am. Soc. C. E. | No. of C. E. graduates 1860-84, inclusive. | Per cent. now M. Am. Soc. C. E. |
|---|---|---|---|
| R. P. I. | 143 | 460 | 31.1 |
| M. I. T. | 26 | 109 | 23.9 |

I have changed the 110 in the third column of the first table to 109, which is the correct number. If the

TABLE XXXIII.—HOURS OF ENTIRE COURSE IN CIVIL ENGINEERING DEVOTED TO THE GENERAL STUDIES ACCORDING TO THE FACE OF THE RETURNS FROM EACH COLLEGE.

| | A. Elementary Mathematics. | | | | | B. Advanced Mathematics. | | | | | | | C. Collateral Adjuncts. | | | | | | | | D. Minor Technical. | | | E. Advanced Technical. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Algebra. | Geometry. | Trigonometry. | Anal. Geom. | Descr. Geom. | Total | Calculus. | Least sq. | Mechanics. | Graph. st. | Physics. | Electricity. | Total higher math. and phys. | French or S. | Eng. Lit., etc. | Botany. | Geology. | Mineralogy. | Metallurgy. | Zoology. | Physiology. | Total Universities. | Astronomy. | Surveying. | Chemistry. | Thermody. | Drawing. | Shop work. | Eng. Technicalities. | Total. | Grand total. | |
| 1. Rens. P. I. | 73 | 39 | 45 | 45 | 76 | 278 | 95 | .... | 110 | .... | 105 | 76 | 386 | 149 | 67 | 48 | 59 | 37 | 58 | .... | .... | 418 | 84 | 235 | 141 | 456 | 145 | 70 | .... | 478 | 687 | 2,231 | |
| 2. Harvard | .... | .... | 57 | 57 | 120 | 234 | 114 | .... | 342 | 57 | 280 | 76 | 869 | 312 | 456 | 102 | 203 | 190 | .... | .... | .... | 1,453 | .. | 450 | 582 | 1,032 | .... | 110 | 114 | 853 | 1,077 | 4,665 | |
| 3. Yale | 32 | .... | 18 | 105 | 50 | 205 | 165 | 20 | 112 | .... | 80 | 40 | 417 | 406 | 30 | 21 | 58 | 104 | .... | .... | .... | 619 | 22 | 40 | 92 | 154 | 30 | 142 | .... | 512 | 684 | 2,079 | |
| 4. Dartmouth. | No report. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 5. Union | 65 | 54 | 65 | 65 | 148 | 397 | 158 | 26 | 140 | 70 | 90 | 275 | 759 | 471 | 337 | 60 | 65 | 25 | .... | 70 | 78 | 1,106 | 52 | 72 | 218 | 342 | 65 | 202 | .... | 942 | 1,200 | 3,813 | |
| 6. U. Mich. | 54 | .... | .... | 90 | 81 | 225 | 180 | .... | 108 | 72 | 90 | 90 | 540 | 360 | 36 | .... | .... | 36 | .... | .... | .... | 432 | 36 | 360 | 90 | 486 | .... | 504 | .... | 990 | 864 | 2,547 | |
| 7. Brklyn P. I. | No report. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 8. Pa. Mil. Ac. | 135 | 100 | 60 | 65 | 230 | 590 | 110 | .... | 135 | 65 | 70 | 30 | 410 | 270 | 262 | ... | 65 | .... | .... | .... | 105 | 702 | 33 | 70 | 248 | 351 | .... | 50 | .. . | 715 | 765 | 2,818 | |
| 9. Columbia | .... | 50 | 62 | 56 | 28 | 196 | 56 | .... | 104 | 94 | 176 | .... | 430 | ... | .... | 28 | 84 | 231 | 112 | 28 | .... | 483 | 112 | 106 | 928 | 1,209 | 140 | 644 | .... | 1,069 | 1,883 | 4,291 | Take surveying and drawing ⅛ |
| 10. Wash. & L. | 100 | 100 | 50 | 75 | 170 | 495 | 150 | .... | 250 | 30 | 150 | 100 | 680 | ... | .... | .... | 120 | 120 | .... | 120 | ... | 360 | 81 | 140 | 200 | 421 | 100 | 80 | ... | 376 | 556 | 2,512 | |
| 11. Mass. I. T. | 28 | 82 | 70 | 45 | 75 | 250 | 95 | 30 | 128 | .... | 100 | 74 | 433 | 270 | 180 | .... | 105 | .. | 15 | .... | .... | 570 | 30 | 255 | 210 | 495 | 45 | 225 | .... | 1,270 | 1,540 | 3,288 | |
| 12. Lehigh | 57 | 76 | 38 | 76 | ... | 247 | 85 | .... | 85 | .... | 152 | .... | 322 | 206 | 190 | ... | 76 | 95 | .... | .... | .... | 627 | 85 | 323 | 76 | 484 | 38 | 152 | .... | 541 | 731 | 2,411 | |
| 13. Univ. Va. | 60 | 60 | 120 | 120 | 240 | 600 | 120 | .... | 240 | .... | 150 | .... | 510 | ... | .... | 240 | 120 | 60 | 120 | .... | .... | 540 | .... | 240 | 180 | 420 | .... | .... | .... | 840 | 840 | 2,220 | |
| 14. Corn'l (C. E.) | 60 | .... | 60 | 60 | 216 | 396 | 120 | 20 | 264 | .... | 72 | 144 | 620 | 36 | 192 | 60 | 108 | 72 | 48 | .... | 12 | 528 | 264 | 330 | 108 | 602 | 30 | 417 | .... | 2,070 | 2,547 | 4,753 | } Fiv'd by |
| (Do. class h'rs). | 60 | .... | 60 | 60 | 129 | 309 | 120 | 20 | 246 | .... | 72 | 79 | 497 | 36 | 192 | 60 | 108 | 50 | 34 | .... | 12 | 492 | 155 | 179 | 108 | 442 | 50 | 167 | .... | 1,343 | 1,540 | 3,280 | } 2½. |
| 15. Tufts | 76 | 38 | 76 | 76 | 120 | 386 | 171 | .... | 100 | .... | 133 | 57 | 461 | 120 | 95 | .... | .... | .... | .... | .... | .... | 215 | 38 | 250 | 367 | 655 | 80 | 540 | 120 | 342 | 1,082 | 2,799 | } Drawing 2 |
| (Do. class h'rs). | 76 | 38 | 76 | 76 | 120 | 386 | 171 | .... | 100 | .... | 133 | 57 | 461 | 120 | 95 | .... | .... | .... | .... | .... | .... | 215 | 38 | 165 | 217 | 439 | 80 | 270 | 60 | 324 | 734 | 2,216 | } h'rs = 1. |
| 16. U. Ga. | 120 | 120 | 120 | 60 | 110 | 530 | 120 | .... | 120 | 50 | 300 | ... | 590 | 160 | 40 | .... | 80 | 20 | 10 | .... | .... | 310 | 50 | 170 | 310 | 560 | 15 | 160 | .... | 280 | 395 | 2,385 | |
| 17. Lafayette | No report. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 18. Wash U. | 25 | .... | 15 | 80 | 430 | 550 | 170 | 40 | 260 | 80 | 220 | 230 | 1,000 | 160 | 320 | 40 | 20 | 20 | 20 | .... | 30 | 610 | 100 | 700 | 240 | 1,100 | 210 | 300 | 320 | 1,240 | 1,970 | 5,230 | } ¼ for lab. |
| (Do. class h'rs). | 25 | .... | 15 | 80 | 330 | 450 | 170 | 40 | 260 | 60 | 200 | 175 | 905 | 160 | 320 | 40 | 20 | 10 | 20 | .... | 25 | 605 | 80 | 480 | 100 | 626 | 180 | 100 | 160 | 1,150 | 1,590 | 4,170 | } & sh'p time |
| 19. Univ. Vt. | 65 | 55 | 75 | 70 | 200 | 465 | 80 | .... | 200 | 100 | 160 | 50 | 590 | 150 | 175 | 15 | 50 | 60 | .... | .... | 40 | 490 | 50 | 350 | 60 | 460 | .... | 200 | .... | 495 | 695 | 2,640 | |
| 20. Kans. Ag. C. | No sufficient report. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 21. Worc. P. I. | 70 | 85 | 35 | 85 | 51 | 326 | 102 | .... | 170 | 72 | 100 | 50 | 494 | 312 | 210 | .... | 20 | 45 | 15 | .... | .... | 602 | .... | 836 | 292 | 1,128 | 98 | 636 | .... | 387 | 1,121 | 3,671 | |
| 22. Ala. P. I. | 100 | 100 | 50 | 50 | 30 | 330 | 60 | .... | 120 | 35 | 100 | .... | 315 | 200 | 140 | 36 | 72 | 112 | .... | .... | .... | 560 | 40 | .... | 100 | 140 | .... | 375 | .... | 635 | 1,010 | 2,355 | |
| 23. Me. Agr. C. | No sufficient report. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 24. Ia. Agr. C. | 133 | 80 | 45 | 80 | 116 | 454 | 85 | .... | 153 | .... | 96 | 119 | 453 | 165 | 301 | 48 | 80 | ... | .... | .... | .... | 594 | 48 | 83 | 246 | 377 | 100 | 436 | .... | 1,019 | 1,555 | 3,433 | |
| 25. Univ. Pa. | 80 | .... | 60 | 180 | 80 | 400 | 240 | .... | 80 | .... | 440 | .... | 760 | 700 | 1,140 | .... | ... | 160 | 40 | .... | .... | 2,040 | 80 | 600 | 120 | 800 | .... | 320 | 80 | 600 | 1,000 | 5,000 | |
| 26. Stevens I. T. | 30 | .... | 30 | 100 | 175 | 335 | 125 | .. | 160 | .... | 300 | 125 | 650 | 360 | 194 | .... | ... | .... | .... | .... | .... | 736 | ... | 64 | 472 | 536 | 275 | 450 | 451 | 876 | 2,052 | 4,190 | |
| 27. Univ. Wis. | 95 | .... | 58 | 75 | 325 | 553 | 143 | 24 | 165 | 210 | 90 | 65 | 697 | 185 | 224 | .... | 125 | 85 | 70 | .... | .... | 689 | 60 | 353 | 144 | 566 | 58 | 140 | 140 | 1,015 | 1,353 | 3,858 | |
| 28. Thayer | .... | .... | .... | .... | .... | .... | .... | 18 | 240 | 132 | .... | .... | 390 | .... | .... | .... | .... | 30 | .... | .... | .... | 30 | .... | 800 | .... | 800 | 140 | 90 | .... | 1,800 | 2,030 | 3,250 | |
| 29. Swarthm. | 72 | 72 | 32 | 72 | 376 | 824 | 144 | .... | 216 | 72 | 216 | 288 | 936 | 288 | 972 | 72 | 108 | 36 | .... | .... | 72 | 1,548 | 144 | 387 | 972 | 1,523 | 108 | 288 | 324 | 484 | 1,204 | 6,035 | |
| 30. C'rn'l (M.E.) | 110 | .... | 50 | 60 | 200 | 420 | 100 | .... | 200 | .... | 300 | 670 | 1,270 | 120 | .... | .... | .... | .... | .... | .... | .... | 120 | .... | .... | 420 | 420 | 250 | .... | 1,680 | 420 | 1,750 | 3,980 | |
| 31. Univ. Mo. | No report. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 32. Univ. Cal. | 92 | 55 | 92 | 55 | 232 | 516 | 185 | 37 | 148 | 37 | 148 | .... | 555 | 296 | 518 | .... | 111 | .... | ... | 74 | .... | 999 | 259 | 518 | 518 | 1,295 | .... | 444 | .... | 803 | 1,247 | 4,612 | |
| 33. Univ. Kans. | 41 | 41 | 49 | 82 | 82 | 295 | 82 | .... | 82 | .... | 147 | 147 | 458 | 82 | 82 | 123 | 41 | 82 | .... | . . | .... | 410 | 224 | 190 | 146 | 560 | .... | 480 | .... | 866 | 1,296 | 3,019 | |
| 34. Univ. Min. | 60 | .... | 48 | 48 | 96 | 252 | 96 | 20 | 60 | 72 | 48 | 48 | 344 | 288 | 144 | .... | 48 | 96 | .... | 60 | .... | 636 | 108 | 450 | 72 | 630 | 260 | 300 | 72 | 1,158 | 1,790 | 3,632 | |
| 35. Rutgers | No report. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 36. Univ. Iowa. | No report. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 37. Corn. C. Ia. | 48 | 45 | 41 | 48 | 99 | 281 | 86 | .... | 45 | 100 | 120 | 63 | 414 | 200 | 336 | 89 | 123 | .... | .... | 48 | 48 | 844 | 75 | 414 | 343 | 832 | 45 | 135 | .... | 745 | 925 | 3,596 | |
| 38. Univ. Ill. | 70 | .... | 55 | 55 | 220 | 400 | 180 | .... | 125 | .... | 169 | 77 | 551 | 180 | 379 | .... | 110 | .... | .... | .... | .... | 669 | 165 | 360 | 360 | 885 | .... | 140 | 72 | 605 | 817 | 3,322 | |
| 39. Univ. Cinc. | No report. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 40. Princeton | No report. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 41. Tex. Agr. C. | 180 | 144 | 50 | 100 | 50 | 524 | .... | .... | 96 | 24 | 100 | 24 | 244 | 200 | 292 | 50 | 50 | .... | .... | 36 | .... | 628 | .... | 300 | 410 | 710 | .... | 720 | 540 | 134 | 1,394 | 3,500 | |
| 42. Univ. Neb. | 30 | 30 | 70 | 90 | 284 | 504 | 170 | 48 | 130 | .... | 326 | 178 | 852 | 315 | 232 | .... | 42 | .... | .... | .... | .... | 589 | .... | 210 | 213 | 423 | .... | 300 | .... | 635 | 935 | 3,333 | |
| 43. Colo. S. M. | 120 | 80 | 120 | 80 | 80 | 480 | 120 | .... | 80 | .... | 240 | 320 | 720 | ... | .... | .... | 120 | 140 | 280 | ... | .... | 540 | .... | 320 | 730 | 1,040 | .... | 640 | .... | 500 | 1,140 | 3,920 | |
| 44. W. Un. Pa. | No report. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 45. State C. Pa. | No report. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 46. Purdue. | .... | 90 | 135 | 71 | 64 | 38 | 398 | 144 | .... | 129 | .... | 152 | .... | 425 | ... | 274 | .... | .... | .... | .... | .... | .... | 274 | .... | 260 | .... | 260 | 100 | 190 | 270 | 186 | 746 | 2,103 | |
| 47. Rose P. I. | 148 | 125 | 50 | 88 | 168 | 569 | 230 | 16 | 492 | 167 | 484 | 17 | 1,400 | 114 | 41 | .... | .... | 31 | 36 | .... | .... | 222 | 296 | 114 | 204 | 614 | 36 | 648 | 480 | 829 | 2,053 | 4,854 | |
| 48. Univ. Tex. | 40 | 40 | 40 | 72 | 48 | 240 | 200 | .... | 60 | 40 | 100 | 72 | 472 | 105 | 350 | ... | 108 | .... | 108 | .... | .... | 671 | ... | 24 | 200 | 224 | .... | 600 | .... | 104 | 704 | 2,311 | |
| 49. Mich. M. S. | 70 | .... | 98 | 58 | .... | 226 | 100 | .... | 70 | 42 | 94 | 172 | 478 | .... | .... | .... | .... | 420 | 296 | 112 | .... | 818 | .... | 443 | 872 | 1,315 | 84 | 458 | 280 | 961 | 1,773 | 4,610 | |
| 50. Mich. Ag. C. | 120 | 120 | 60 | 90 | 120 | 510 | 120 | .... | 240 | 20 | 150 | 120 | 650 | 90 | 180 | .... | .... | 20 | 40 | .... | .... | 426 | 60 | 90 | 80 | 230 | 120 | 300 | .... | 180 | 600 | 2,410 | |
| 51. Univ. Ga. | No sufficient report. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 52. Mont. S. M. | .... | .... | .... | 110 | 120 | 80 | 140 | .... | 100 | 45 | 200 | 50 | 535 | 200 | .... | 62 | 200 | 150 | 200 | 60 | 400 | 1,272 | 40 | .... | 872 | 912 | .... | 660 | .... | 533 | 1,193 | 4,292 | |

(Nos. 26 and 30 in this list are colleges which have mechanical courses only, and accordingly the figures given are for that course. Similarly, Nos. 43, 49 and 52 have mining courses only, which is that given. This same note applies also to Table XXXIV.

point of view, and in any case can only be a general one, it is contended that the considerations set forth above should modify the conclusions drawn in your issue of Nov. 17. Palmer C. Ricketts.

Troy, N. Y., Nov. 25, 1892.

(One important reason for the apparent discrepancy between us and our correspondent is his inclusion of dead men in his totals. He thinks that these are "properly included." We think it plainly unfair to include them under all the circumstances, which we will not again rehearse. As we are necessarily the less interested party, we feel that our judgment on this point is more likely to be impartial.

On the other hand, we so far agree with our correspondent as to the effect of the unavoidable advantage which the college having several courses in engineering enjoy over those having a civil engineering course only, as to consider that the four colleges which conspicuously lead all the rest should be regarded as standing on a substantial footing of equality in the particular point we are discussiong, and that the apparent fractional differences between them should not be regarded. Our best judgment was, and is, however, that if the figures warrant any conclusion as to the standing of the several colleges in this respect, they warrant the conclusion that the colleges stand above in the order shown, though by smaller shades of difference.

There is no real conflict as to the statistical record when reduced to the same basis. Our record covered 1,073 members and associate members (only about 25 of the latter) out of 1,135 borne in the last list of members. Of these 130 were living graduates of Troy, including as "graduates" those who more than half-completed their course in every case. We adopted this rule before beginning the tabulation as the fairest basis, for our purpose at least. We still consider it such. Our correspondent in his last letter claimed 118 living graduates in the same list of members. The difference of 12 are either graduate associate members or these non-graduate members.

On the other hand we find 42 graduates (including the aforesaid partial graduates) of the Mass. Inst. Tech. among the same 1,073 members. Our correspondent says there are only 34 of these who are formal graduates. It may be so. If our correspondent desires to find out we offer him the free use of our pile of individual returns. That there were 42 men who by our standard were entitled to be credited to the M. I. T., however, is absolutely certain. Our system of tabulation was too carefully checked and counter-checked to admit of any error in that respect.

This is not the first time in this inquiry when we have had occasion to sigh for the temporary use of a little omniscience, that we might do absolute justice between college and college, without having to ensure it by saying nothing about either. As we could not have it, we have done the best we could, thankful that we were at least given credit for seeking to do justice.—Ed.)

## SEWAGE PURIFICATION IN AMERICA.

### East Orange, N. J.

(Continued from p. 424.)

The East Orange chemical precipitation and intermittent downward filtration plant for the purification of sewage was fully described in Engineering News of Jan. 5 and 19, 1889, and Feb. 15, 1890.

A brief description of the methods employed will be repeated before giving later information regarding the works.

East Orange is a suburb of New York with a population by the census of 1890 of 13,282, the township having grown to this size from a population of 8,349 in 1880. The present population is probably not far from 14,500.

The sewerage system was completed ready for house connections in the spring of 1888.

The sewage receives, and has thoroughly mixed with it at the disposal works, lime and sulphate of alumina. It then passes to settling tanks where much of the solid matter is retained and from which, after passing upward through a small amount of coke, the more or less clarified liquid flows to the filtration area. This area includes 14.7 acres, all underdrained, some of it being in beds 100 ft. long by 50 ft. to 100 ft. wide and the remainder having shallow furrows running in one direction 4 ft. apart, from which the sewage soaks into the land on each side. The filtration area being restricted in size, by local conditions, and the soil being of a retentive character it has been supplemented by small artificial beds of coke and gravel.

The sludge is drawn from the tanks, when the latter are cleaned, to a sludge well from which it is conveyed with the aid of air under pressure to Johnson filter presses and made into cakes.

On Nov. 24 the writer visited East Orange and obtained the following additional information from Mr. John J. O'Neill, Township Engineer, who has charge of the sewerage and sewage disposal systems:

There are now about 33 miles of sewers and 1,685 connections. There have been put in place more than 60 flush tanks, but, owing to a scarcity of water last summer, many (probably nearly all) were cut off, since which the sewers have been flushed by plugging up for 24 hours or so. Formerly the water company charged the township $20 for making a connection with a flush tank and $25 a year for water, but under a recent contract water for flushing is furnished without charge.

The daily flow of sewage is about 1,200,000 gallons, which is less than it was two years ago. The decrease is said to be due to the fact that the leakage of ground water into the sewers is decreasing. This leakage has in the past been estimated as equal to the total amount of sewage proper.

The chemicals used as precipitants have always been lime and sulphate of alumina. The amount of chemicals per gallon of sewage now used could not be ascertained, but in 1890 it was given as 3 grains of lime and 2 of sulphate of alumina per gallon. Mr. O'Neill states that about 5% more per gallon of the chemicals is used than at the time of the report of the Town Improvement Society, Feb. 2, 1891, which stated that one barrel of lime and 300 lbs. of alumina, at an expense of about $6 per day, were used, the average amount of sewage treated at the time having been estimated at 1,330,000 gallons.

The lime is bought of a local dealer at 95 cts. per barrel, delivered at the works. The sulphate of alumina costs about 1¼ cts. per lb., at the works, and is bought by the carload of Harrison Bros. & Co., New York. A porous alum has occasionally been used which costs 2⅜ cts. per lb., but is said to be more efficient than the sulphate of alumnia.

The chemical character of the sewage is quite constant, except as affected by ground water.

All of the sewage passes upward through a body of coke some 2 ft. in diameter and 4 or 5 ft. deep before passing onto the filtration area. This coke is renewed twice a week and is independent of beds of coke and gravel located in the midst of the filtration field which are used for downward filtration.

The sewage is put upon one tract of land for from 6 to 8 hours after which this tract has 36 hours rest.

Mr. O'Neill writes under date of Nov. 26 that the cost of operating the disposal works for the nine months from Jan. 1, to Oct. 1, 1892, was $3,935 for labor and $2,146 for chemicals, coal, oil, canvas (for the filter press), sundries, repairs, etc. This makes a total of $6,080, which is at the rate of about $676 per month, or about $8,100 per year.

Appending the above cost of operating the disposal works for the first nine months of 1892 to the figures given in the report of the Town Improvement Society, we have the following operating expenses for the periods named, with the monthly averages for the same periods:

| | For period. | Average per month. |
|---|---|---|
| July 9, 1888, to Feb. 28, 1889..... | $3,936 | $562 |
| Mar. 1, 1889, to Feb. 28, 1890..... | 8,950 | 746 |
| Mar. 1, 1890, to Jan. 2, 1891..... | 8,815 | 881 |
| Jan. 1, 1892, to Oct. 1, 1892..... | 6,080 | 676 |

On a basis of 14,500 population, the average cost per year per inhabitant for operating the disposal works during the first nine months of 1892 was about 56 cts. What degree of purification has been attained this year cannot be stated, but it is certain that no serious complaints have been made and the works, including the filtration area and the brook which receives the effluent, appeared to be in excellent condition on Nov. 24. Twice within a short time the writer has passed through the street upon which the filtration area abuts and close by which the chemical works are situated, without detecting anything to betray their character. The decreased cost of operating the works this year is said to be due to obtaining greater efficiency from the labor and not to using less chemicals.

FIG 44. JOHNSON SLUDGE FILTER PRESS, SEWAGE DISPOSAL WORKS, EAST ORANGE, N. J.

The writer found the effluent as it was discharging into the brook to be somewhat cloudy but odorless. To the eye it appeared about like the effluent from the chemical precipitation plants described in this series of articles, but not as good as the effluent from the intermittent filtration plants visited.

The foreman at the works, Mr. Richard Linehan, states that he was formerly engaged upon the sewage purification plants at Chiswick and Ealing, England.

The force at the works now includes a foreman, engineer and five laborers, one man being employed at night. The tanks are cleaned three times a week after which their sides are whitewashed or treated with some other disinfectant. The scum boards between the first and second compartments of the tanks, the attendant stated, did not float readily, as intended, and are now kept stationary at about 2 ft. from the bottom.

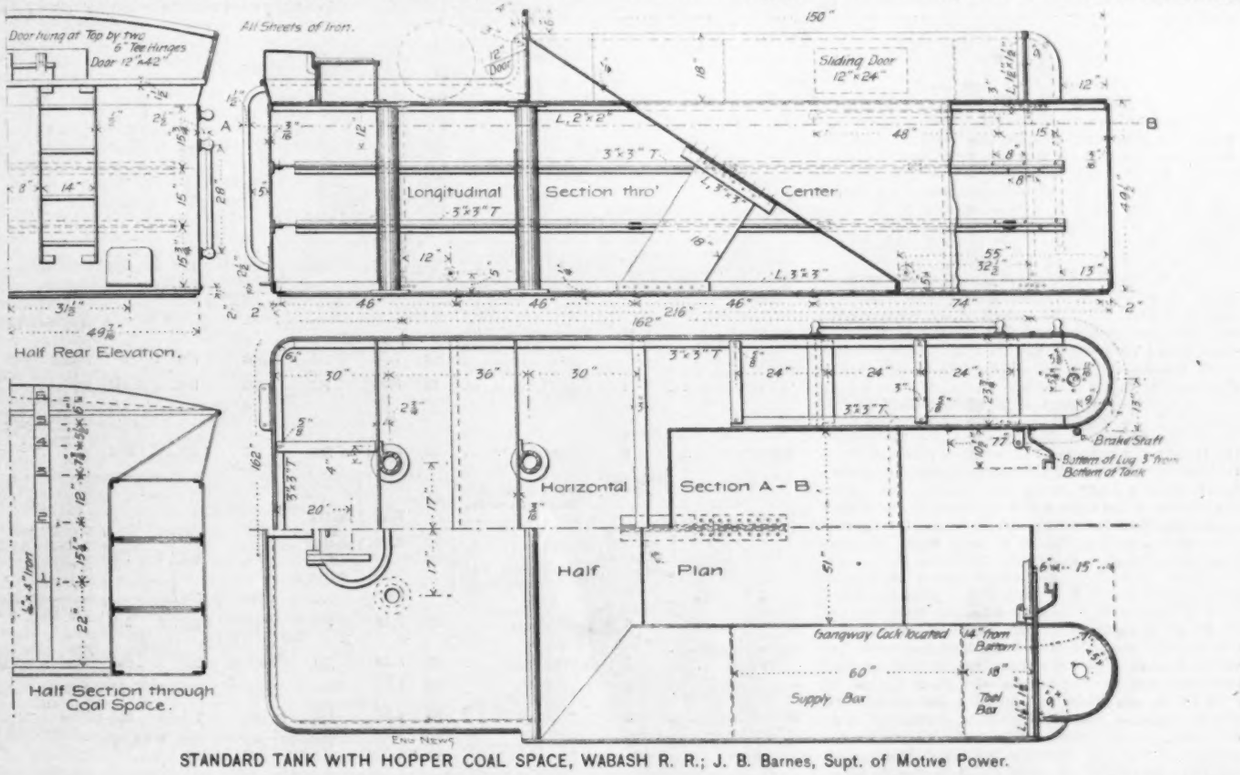
The Johnson filter press is shown by the ac-

companying view, Fig. 44. The sludge cakes from the press have an average thickness of fully 1 in. and a diameter of about 25 ins. There are about 35 cakes to each pressful and the attendant stated that the press is filled six or seven times a day. The sludge cakes are generally drawn to the township poor farm and there buried or disposed of otherwise. Farmers do not seem to wish the sludge, although it has been offered free for the carting away and some has been so taken. It is stated that some sludge has been sold at 50c. cts. per load, but the amount is small. The sludge has been burned in a small furnace ventilated to the boilers, but objections were made on account of the odors, more probably fancied than real.

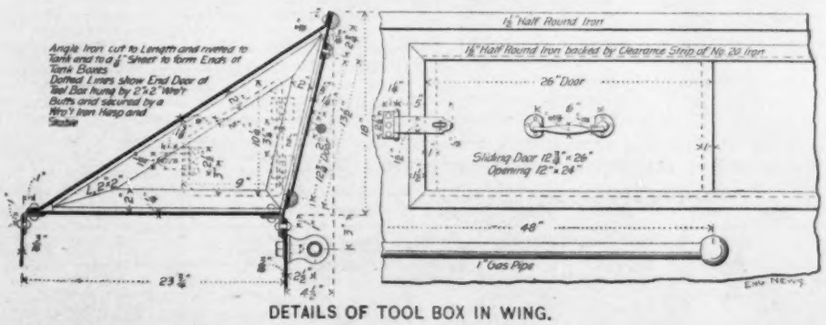
Both the attendant and Mr. O'Neill stated that there has been no trouble at the works from frost

## SOME NEW IDEAS IN LOCOMOTIVE TENDERS.

A locomotive tender which does not keep the fireman busy shoveling coal from the rear end up to the foot board is shown in the accompanying drawings. The tender was designed by Mr. J. B. Barnes, Supt. of Motive Power and Machinery, Wabash R. R., and has given such satisfaction in service that it has been adopted as standard on that road, and all new tenders or old ones built over will be made to conform to it. As seen by the drawings, the principal feature is the carrying of all the coal on inclined planes, so that it slides down to the front within easy reach of the fireman as fast as he shovels it away. In place of the wooden tool boxes usually placed on the rear of the tank, this tender has metal tool and supply




STANDARD TANK WITH HOPPER COAL SPACE, WABASH R. R.; J. B. Barnes, Supt. of Motive Power.


Angle Iron cut to Length and riveted to Tank and to a ¼" Sheet to form Ends of Tank Boxes
Dotted Lines show End Door of Tool Box hung by 2"x2" Wrot Butts and secured by a Hinged Iron Hasp and Staple
½" Half Round Iron
1⅛" Half Round Iron backed by Clearance Strip of No. 20 Iron
26" Door
Sliding Door 12¾"x26" Opening 12"x24"
1" Gas Pipe
ENG NEWS

DETAILS OF TOOL BOX IN WING.

but the report of the Town Improvement Society, mentioned above, states:

A visit during the recent cold spell convinced the committee that the frozen ground prohibited any filtration through it, while the coke beds can be worked under all conditions of weather.

The above statement, unsupported as it is by details, cannot be considered as proof of inefficiency of the filtration area during cold weather, but the experiments of the Lawrence Experiment Station of the Massachusetts State Board of Health prove that cold weather, coupled with sufficient snow upon the filter beds to chill the applied sewage, almost or wholly stops nitrification and greatly reduces the amount of purification.

Sand and soil works its way into the underdrains and is removed at the junction of lateral and main drains through a vertical length of sewer pipe.

boxes with sliding doors, built in the wings. It is not necessary, therefore, to make a trip to the rear of the tender whenever an extra tool or a handful of waste is needed.

A very good feature of the design is the substantial iron ladder on the rear end, furnishing the easiest means of access to the manhole. A flat strip of iron riveted to the rear incline of the coal space is marked in plain figures with the height corresponding to different quantities of fuel. Thus the engine crew can check quite closely the amount of fuel which is charged against them at coaling stations. Mr. Barnes informs us that six tons of coal can be carried on this tender without risk of loss by shaking off, and seven tons can be carried more easily than five could with the old-style tender.

A criticism which might naturally be made upon this design is that the dumping of coal from overhead chutes upon the incline at the back of the coal pit would be apt to spring the sheet and open the seams. It will be noted, however, that a substantial brace is placed underneath this sheet, and we are informed that the tank has given no trouble and none whatever is apprehended from leakage at the seams.

## NOTES FROM RECENT WATER-WORKS REPORTS.

A pressure reduction force of eight men was employed on the water-works of Rochester, N. Y., during the year 1891 to balance the daily inflow and outflow from the distributing reservoir. The pressure is regulated by closing or opening a 16 and a 12-in. stop valve at one station and a 16-in. at another. The stations are provided with pressure gages, telephones and a fire alarm gong, the valves always being completely opened at an alarm of fire.

The following description of the service with accompanying comment is from the last annual report of Mr. E. Kuichling, M. Am. Soc. C. E., Chief Engineer of the Rochester water-works:

The limit for the pressure has in general been taken at that which prevails when no restriction is applied during the hours of greatest daily consumption. At such times, therefore, the valves are fully opened, and as soon as the gages indicate a reduced consumption they are again partially closed. It will readily be perceived that numerous changes in the position of the valves are necessary every day in order to maintain a uniform pressure at the two stations, also that during certain hours, usually from about 7 to 11 a. m., there is virtually no reduction of pressure whatever. At night, on the other hand, the pressure is considerably reduced to compensate for the excess used during the day. This plan of maintaining a nearly uniform pressure for seventeen consecutive hours, from about 5 a. m. to 10 p. m., with a lower pressure during the remaining seven hours of each day, was believed to be the most satisfactory one to the public, and comparatively few complaints about it have been made. In extremely warm and cold weather, however, as well as on Mondays, the ordinary rates of consumption are greatly increased, so that the pressure with the valves fully opened is inadequate to raise the water to the second stories of many buildings in certain high districts; and it will therefore seem necessary to modify the above plan by reducing still more the pressure during the day and raising it for an hour or two during the night, in order that a fair supply of water may be delivered into small storage tanks in the upper stories of buildings in said high districts.

The observations made during the night at the two stations, by using the throttled stop valves as water meters, demonstrate that there is comparatively little leakage in the system of distributing pipes; and it is also found that, in cool weather, the daily consumption is not greater than the supply furnished by the conduit, so that at such times no material reduction of pressure is made, except when necessary to replenish the reservoirs from previous over-drafts. It is therefore proven that when the water is not deliberately wasted by carelessness, leaky fixtures, or the criminal abuse of privilege, such as propping open the valves of water closets in the absurd expectation of thereby efficiently flushing house sewers, a fair supply is available for every inhabitant. These periods are, however, of short duration, and with the advent of either hot or very cold weather, a waste of water is soon commenced and continued by inconsiderate people. Fortunately the number of the latter is not very large, otherwise the difficulties now experienced would become greatly aggravated.

## THE DISPOSAL OF REFUSE.*

By Mr. G. Watson (Leeds).

(Concluded from page 319.)

### Method IV.—Combustion.

It is easy to burn ashbin refuse by means of arrangements the most simple to the most elaborate—from a heat fire in the open air to a destructor involving heavy capital outlay; but is is by no means easy to burn it without any smoke or noxious fumes being given off. However, burning is now carried on in many places, and in some very satisfactorily; and this is the process to be recommended, and which is dealt with at length in another part of the paper.

Street sweepings contain sufficient horse droppings to be salable as manure, in some cases, though their value is largely affected by the nature of the road material and the quantity of mineral dust contained. They are often tipped with less disastrous results than are generally found from tipping other kinds of refuse, and they may be readily burned.

The subject of the disposal of excrement, or sewage proper, is much too great to be more than touched upon. Briefly, it may be said that the use of the public sewers to convey a mixture of domestic sewage and liquid trade refuse, diluted with a goodly quantity of town's water, and, in many cases, with surface water from the streets, is the system now generally in favor with local authorities for getting rid of the most dangerous class of refuse. Its ultimate disposal is, in the great majority of cases, not fully provided for. It is generally turned into the nearest water course, intercepting sewers being provided to carry it to a point below the town producing it. The evils resulting from the use of sewers as channels for putrescible matter are very serious. Sewer gas is one of the most important, the variation of level of the sewage, as the flow becomes greater or less, causing the surfaces about the normal level to be alternately wet and dry for considerable periods, so that a fresh deposit is constantly made which very soon putrefies. Slime also collects on the crown of the sewer. Leakage is another danger more sudden in its effects. In cases which have come under the knowledge of the author drains have been laid from highly-rented houses, with the joints ½ in. or more apart. If the ground is at all porous it will become a sort of spongy cesspool clogged with foul matter for a considerable distance.

Filtration through sand, and (by pressure) through fibrous material, and precipitation by chemical and mechanical processes, are systems more or less imperfectly adopted for dealing with liquid refuse, and they leave a large residue in the form of sludge, which is in some places simply deposited on the ground in heaps or sloughs. It is often sold as manure after more or less preparation; and notably, at Ealing, sewage sludge is being burnt in the destructor very successfully. This is the proper method of disposal.

The London County Council now barges its sludge to sea in what is known as the "sludge fleet," and it is claimed that the amount of black mud stirred up by the passage of a vessel to or from the port of London is now less than formerly. It remains to be seen whether the enormous dredging operations carried on in the docks* and the river will eventually be reduced, but it is to be feared that the sludge is, like the stone of Sisyphus, continually rolling back, in spite of the gigantic labors of constructing intercepting sewers all the way to Barking and Crossness. The "sludge fleet" rolls the stone a little higher, but it is by no means at the top of the hill yet.

Intermittent downward filtration and irrigation (except in frosty weather), and Webster's electrical process, followed by combustion of the solid matter, are final and complete methods of sewage disposal, while those systems which aim at producing manure may be considered as complete when a market can be found for the product.

Collection from house to house, either on the pail system or on the privy and ashpit system, is still largely practiced, and is in many respects strongly to be recommended, particularly in that it provides the most direct means of conveying the noxious material to destructors.

The liquid waste products of manufactures are rarely dealt with by those who produce them. They are generally allowed to flow into the public sewers, which are maintained, together with the outfall works, by rates pressing equally on the whole community; or, worse still, are turned into streams and rivers.

### Destructors.

Since 1876 destructors have been gradually adopted in a large number of towns, and in spite of many defects which have appeared from time to time in the working of the system, it has now become generally recognized by sanitary engineers as the right one.

There is good reason to suppose that fire was the agent chiefly employed by the ancients in the disposal of their refuse. It is said that the Jews worshipping Moloch offered their children as sacrifices to the fire demons in the valley of Gehenna or Tophet, and the valley being afterward defiled by Josiah, was used for the burning of the refuse—instead of the children—of Jerusalem.** It may also be noticed that among the many interesting antiquities of ancient Rome is an inscription on a pillar: "Take your refuse further, or you'll be fined."***

In view of the many fragments of an older civilization it is curious to observe the frequent suggestion now made in the press, that all putrescible matter should be burned by householders on their domestic fires. The author supposes that idea to be put forward because domestic smoke, although largely responsible for fogs and dark skies, lacks something of pungency, and needs the addition of a spice of danger to make it really enjoyable.

It appears that one of the earliest attempts to burn refuse in a destructor, in this country, was made by Messrs. Meade & Co., in 1870,* and from that time to the present inventions in great variety have been developed. It would be impossible at this time to deal with all of these.

Pickard's Gourmand had secondary fires fed with additional fuel for cremating the fumes.

TABLE VIII.—DESTRUCTORS.

| Name of town. | Number of cells. | Make of cells. | Average tons burnt per day of 24 hours. | Tons per cell per = 24 hours. | Height of chimney in feet above ground level. | Total cost of destructor plant. | Cost per cell. | Cost of burning per ton; returns deducted in each case. | | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | £ | £ | s. | d. | |
| Battersea | 12 | Fryer's | 81½ | 6.81 | 180 | 9,054 Hammerton street = for 12 cells. | 7.55 | 2 | 2¼ | |
| Bradford | 24 | Fryer's fitted with Horsfall's steam jets | 170 | 7.09 | 180 | 10,000 | 833 | 1 | 5 | Fume cremators. Steam jets not included in first cost. |
| Ealing | 4 | Fryer's | 20 | 5.00 | 143 | 2,465 | 616 | 0 | 4¼ | First cost does not include foundations, value of steam, etc., put as 9¾d. per ton burnt. |
| Hornsey | 6 | Warner's | 35 | 5.83 | 217 | 6,500 for 10 cells. | 1,083 | 0 | 10¼ | |
| Leeds: Burmantofts 14. | | Fryer's fitted with Horsfall's steam jets | 216 | 6.00 | 2 shafts = 150 | 7,282 | 728 | 1 | 7¼ | Steam jets not included in first cost. |
| Armley road 12. | | Fryer's | | 6.00 | 1 shaft = 120 | 7,464 | 622 | | | |
| Kidacre street 10. | | Combination of Fryer's and Horsfall's | | 6.00 | .... | 8,000 | 800 | | | Existing chimney not included in first cost. |
| Leicester | 6 | Fryer's | 33 | 5.50 | 160 | 7,00 for 12 cells. | 1,166 | 1 | 3 | |
| Newcastle-on-Tyne | 6 | Warner's | 48 | 8.00 | 150 | 9,000 | 750 | 1 | 0¼ | First cost estimated before completion. |
| Southampton | 6 | Fryer's | 50 | 8.33 | 160 | 3,723 | 620 | Profit | 2¾d. | Value of steam put at 9¾d |
| Bolton | 8 | " | 50 | 6.25 | 180 | 6,200 | 775 | 0 | 2¼ | Great return from sale of mortar. |
| Bury | 4 | " | 20 | 5.00 | 180 | 3,500 | 875 | 1 | 10½ | |
| Liverpool | 12 | " | 96 | 8.00 | 175 | 7,050 | 588 | 1 | 3 | Exclusive of interest on first cost. |
| Salford | 6 | " | 28 | 4.66 | 180 | 2,400 | 400 | 1 | 6 | |
| Whitechapel | 8 | " | 60 | 7.50 | 180 | 8,671 | 1,084 | 2 | 3 | Cost of chimney alone, £2,500. |
| Oldham | 6 | Horsfall's | 37½ | 6.25 | 180 | 3,438 | 573 | 1 | 1 | Existing chimney not included in first cost. Value of steam not allowed for. |
| | | | | | | | 12,668 | | | |

Average cost per cell £767 (exclusive of site but inclusive of boilers, etc.).

TABLE IX.—SHOWING PROGRESS OF THE DESTRUCTOR SYSTEM IN GREAT BRITAIN.

Destructors adopted in year:

| 1877. | 1878. | 1879. | 1880. | 1881. | 1882. | 1883. | 1884. | 1885. | 1886. | 1887. | 1888. | 1889. | 1890. | 1891. | 1892. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Leeds<br>Manchester<br>Birmingham | | Blackpool<br>Heckmondwike<br>Warrington | | Blackburn<br>Bolton<br>Bury<br>Bradford<br>Glasgow | Derby<br>Ealing<br>Hull<br>Nottingham<br>Salford. | | City of London<br>Richmond (Surrey)<br>Leicester | Southampton<br>Burnley<br>Winchester | Preston<br>Newcastle-on-Tyne<br>Whitechapel<br>Buxton | Batley<br>Battersea<br>Bournemouth | Hampstead<br>Broughton<br>Longton | Oldham<br>Hastings<br>Hornsey | | Royton<br>Liverpool<br>Hyde<br>Bristol<br>Huddersfield<br>Cheltenham.<br>Woolwich<br>Blackpool<br>Eastbourne | Hyde<br>Edinburgh<br>Govan |

An idea put forward in a paper by Dr. Miller Bruce in 1891** was to have a sort of traveling destructor something like a traction engine to go its rounds at night, and browse as it went along upon the refuse collected from door to door—veritably an awe-inspiring machine.

Mr. J. Wilkinson, of Birmingham, erected furnaces at Montague St., into which the gases from drying excrement were forced and burnt.

Mr. John Young, of Glasgow, has a special system of burning refuse which appears to be successful.

* Paper read before the British Association.

* Vide letter to the "Morning Post," August 25, 1891.

** See Webster's Dictionary, under "Gehenna;" also Boutell's Bible Dictionary, under "Gehenna."

*** Article by E. T. Wittington, M. A., in "The Hospital," July 16, 1892, quoted from Lucian's "Ancient Rome in the Light of Recent Discoveries."

* Report to the Local Government Board on, "The Destruction of Town Refuse," by Thomas Codrington. C. E., 1888.

The Beehive destructor, with one grate over another, invented by Mr. Stafford, at one time achieved some popularity, but it has not been found satisfactory and no new ones, so far as the author is aware, are being built. The Nelson destroyer was patented in 1885 by Messrs. Richmond and Birtwhistle.

The "carbonizer" was invented by Mr. Fryer for the purpose of converting vegetable refuse into charcoal, but it has not proved a success; and at Derby alone, of the four towns that adopted it, is it still in use, and there only to a very limited extent. In the United States of America the Engle crematory is in use,* and Mann's furnace is working at Montreal,** Canada.

The refuse furnaces which appear to the author to be of most interest to sanitary authorities at the present time are the Fryer furnace, Warner's destructor, Healy's furnace, Whiley's furnace, and the Horsfall furnace. Table VII. (page 320 ante) gives particulars of the working of destructors in fourteen places. Table IX. shows roughly the order which towns have adopted the system.

The Fryer destructor,*** as illustrated in Fig. 1, is the one which has been most largely used; and it undoubtedly reflects great credit on its inventor. Broadly, it consists of a block of furnaces or cells, each internally about 5 ft. wide by 9 ft. long, generally placed "back to back" in pairs, with a flat top on to which the refuse is tipped. The furnaces are covered by arches with their crowns about 3 ft. 6 ins. above the grates, and they slope from back to front about 1 in 3. The back end of the furnace is in each case divided by a wall into two halves. At one side the slope is carried up more steeply to a feeding hole into which the refuse is shoveled from above; while the other half bends downward and forms an opening into the main flue for the escape of the products of combustion. Only one feed opening is provided for each pair of cells when they are placed back to back. A larger opening fitted with a cover is placed over the middle of some of the furnaces, through which infected bedding and diseased meat can be put into the furnace. It may be mentioned that the space is not big enough to be well adapted for this purpose, and bulky articles must be divided before they will go in. An inclined roadway is generally provided at all destructors up which the rubbish can be carted to the top of the furnaces.

The refuse is moved forward in the furnaces by pushing from above and raking from below through the firedoor; the clinkers being drawn out when thoroughly burnt. Over 80% of the destructors now working have attached to them a fume cremator; and most of these are on Mr. Jones' patented system. Briefly, this appliance is an additional furnace in which coal, coke-breeze, and, in some cases, sifted cinders from the refuse are burned, and through which all the waste gases from the destructor have to pass on their way to the chimney. The temperature at which it is sometimes claimed to burn is about 1,400° Fahr., but it is open to doubt whether in practice it often exceeds an average of 900° Fahr. But even this is a considerable advance on the temperature of the furnace without it.

Temperatures taken with a Siemens pyrometer at Whitechapel ranged from 180° Fahr. to 1,000° Fahr.; the average of the eight cells being 490° Fahr. A dead fire, ready to be clinkered, gave off gases at 290° Fahr. to 300° Fahr.* At Ealing the temperature of the flues from the furnaces averaged just over 631° Fahr., while the temperature at the Bradford furnaces is said to have been 350° Fahr. before the application of Horsfall's steam jet and Jones cremator. According to Professor Wanklyn a temperature of at least 1,250° Fahr. is necessary to destroy all septic poisons in the fumes; and, therefore, it is not much to be wondered at that the cremator has been applied to so large a proportion of low-temperature furnaces. That these precautions were not taken without a good deal of pressure and complaint may be judged from the amount of prejudice that still lingers in many minds against destructors. Mr. Jones' fume cremator has been invaluable in checking the nuisance that threatened to prohibit destructors altogether; but it has one drawback in the shape of the expense entailed in extra fuel and labor. At Bradford the expense is said to have been £1,056 for two cremators in 1890; while at Ealing it is put down at only £130 per annum for one. At Hornsey, on the other hand, one cremator was costing at the rate of £800 per annum, until its use was abandoned on account of the expense. At Leicester it is fed with screened cinders, and only the cost of a man's time in feeding it is set down as expenditure.

Warner's destructor** is already in use at Newcastle-on-Tyne, Hornsey, and Bournemouth, very successfully. In general arrangement it is very similar to Fryer's (just described); but it differs from it in having a special charging arrangement, consisting of a hopper with a movable bottom. A charge is put into the hopper and a plate put over it to prevent the escape of smoke and fumes. A lever is then moved which releases the bottom door and allows the refuse to fall on to the drying hearth. Another important improvement is the provision of dampers to the flues of each furnace, which can be closed during the process of clinkering (during which the firedoors have to be wide open) and so keep up the heat of the furnace during the operation. Special dust-catching arrangements are also included in the design; and sometimes forced draft produced by a powerful fan is applied.

Healey's destructor,* an example of which has been erected at Bradford, has for its principal feature an arrangement of flues whereby the gases from one furnace have to pass over the bright fire of another in a more forward state of combustion before escaping. The furnaces are worked in pairs, and the gases alternately made to pass from one to the other by means of dampers. The provision of a movable drying floor over the furnace is also described, upon which the charge is allowed to rest until it is thoroughly dried. The floor is then allowed to fall and drop it on to the grate.

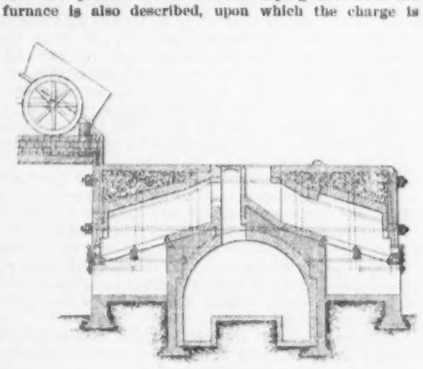


Fig. 1. The Fryer Destructor.

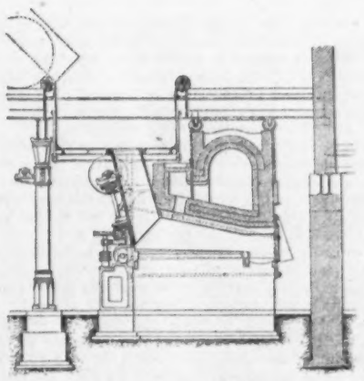


Fig. 2. Whiley's Destructor.

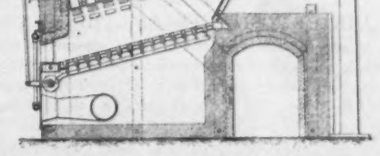


Fig. 3. The Horsfall Refuse Furnace.

Whiley's destructor,** shown in Fig. 2, is the patent of the superintendent of the Manchester cleansing department, and is designed primarily with a view to labor saving. A trough or hopper is provided at the back into which the carts tip direct. A spout or tube is arranged through which the refuse falls on to movable eccentric grate bars, similar to Vicat's patent grate bars. These bars automatically traverse the refuse forward in the furnace, and finally push it against a flap door which opens and allows it to fall out. A means of changing the speed of the bars from time to time is provided by friction gearing; in which the driven wheel running on the face of the driving disk can be moved nearer to or further from the center of the disk, which revolves at a constant speed. Some trouble has been experienced from the refuse sticking in the hopper, but no doubt that will be overcome. A more serious drawback to the system is that the grate bars have so much motion that they would let fine refuse drop through unburnt; and are, therefore, only suitable for places where, as at Manchester, they screen all refuse, or at least select it. The author takes exception to the method of pushing out the clinker, as it causes the door to be continually flapping so that it fans cold air into the furnace. At the same time it is only fair to say that with screened Manchester refuse a very fair temperature, said to be about 1,000° Fahr., is maintained, and the amount burnt is claimed to be 10 tons per cell per day.

The Horsfall refuse furnace*** is shown in Fig. 3. This furnace differs strikingly from those previously described in that it burns at a temperature of over 2,000° Fahr., and this immense heat when applied to raising steam renders sufficient power available to more than repay the cost of burning and collection both.

The destructor is somewhat similar in dimensions and in the shape of the furnace proper to the Fryer furnace, each cell being just over 5 ft. wide. One of its most important features is the jet of steam which forces air into the closed ashpit by means of surface friction at a pressure equal to ½ in. of water. Also, there is a special feature in the arrangement of flues and flue openings, which, instead of being at the back, as in Fryer's furnace (in which the gases from the drying refuse pass away straight into the main flue), are placed in the front of the reverberatory arch over the hottest part of the fire. Thus the gases given off by the drying refuse at the back have to pass over the hottest top of the reverberatory arch and then down through part of the fire (at a temperature of 2,000° Fahr.) and through small apertures in a red-hot reverberatory arch before they can escape. The flues pass along over the top of the reverberatory arch and then down through cavities in the side walls to the main flue underneath.

Thus the furnace is practically surrounded with hot gases which have the maximum effect in drying the green refuse. A longitudinal trough or hopper is provided at the back, into which the carts tip direct; but instead of a shoot being provided, as in Mr. Whiley's, to convey the refuse from the hopper to the furnace, the hopper is brought right down to the grate bars, and the opening at the back is made the full width and height of the furnace. The grate bars are Settle's patent,**** and are of the rocking type without either excessive motion or wide spaces, those bars on to which the refuse first falls being "dummies," that is, without air-spaces. The grate surface proper is 28 sq. ft. in each cell. The refuse is gradually moved forwards by a wave-like motion, and deposited in the form of clinker on the wide "dead-plate," where it remains until the attendant comes along to remove it. Thus the continual admission of cold air to the furnace is avoided, and also less labor is required in raking the clinker off the dead-plate than in shoveling it up off the ground, while all handling of the refuse is obviated until after it has been reduced to clinker. With the use of these bars an output of 9 tons per cell per day has been certified.

A separate mattress chamber in connection with the main flue is a great convenience, as large articles can be put into it whole and are speedily destroyed.

No general rule can be laid down for the calorific value of refuse, as it varies so much in different localities. From rough statistics, which do not include excrement, the author finds the refuse of two manufacturing towns to be of about the following proportions: Market garbage, 6%; fish and butcher's offal, 4.6%; street sweepings, 40.4%; ashbin refuse, 50% of the whole. Until recently it has been generally believed that 1 ton of ashbin refuse gives off heat in combustion equivalent to 1 1-5 I. HP. for 24 hours.* That is equal to about 6 I. HP. per cell of the destructor from which the figures were obtained.

Professor Forbes, however, early in the present year, dealt with the subject in one of his Cantor lectures, and also in a letter to the press,** in which he stated that, burning at 2,000° Fahr., the ashbin refuse of any population was sufficient to give steam to furnish electric light at the rate of one lamp of 8 c. p. per head for two hours every night of the year.

A calculation, based upon analyses of the products of combustion of Mr. Horsfall's experimental furnace at Leeds in 1888, and upon the specific heats and weights of the component gases, shows that with a boiler efficiency of .8, 1,192 lbs. of water at 32° Fahr. can be converted into steam at 70 lbs. pressure per sq. in. by the combustion of ¼ ton of ordinary ashbin refuse in one cell in one hour. Supposing an engine to consume 20 lbs. of steam per I. HP. per hour, we have theoretically from one cell on this system 59.6 I. HP. all the time it is working.

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* Report to the Local Government Board on "The Destruction of Town Refuse," by Thomas Codrington, C. E., 1888.
** London "Standard," August 14, 1891.
* Paper by Dr. S. S. Kilvington before the American Public Health Association, see "American Machinist," December 26, 1890.
** "American Machinist," December 28, 1890.
*** Patent No. 3,125, A. D. 1876.
* "Report on the Destruction of Town Refuse." By Thomas Codrington, C. E., 1888.
** Patent No. 18,719 (1888).

* Patents No. 2,369 (1889); 7703 (1885); 1,005 (1892).
** Patent No. 8,271, A. D., 1891.
*** Patent No. 8,000 (1887) and Patent No. 14,709 (1888).
**** Patent No. 15,482 (1885).

The following are the data:

One Cell Destructor Burning Six Tons of Ashbin Refuse per Twenty-four Hours.

Average Composition of Gases:

| | Per cent. |
|---|---|
| Oxygen | 15.20 |
| Carbonic acid or carbonic oxide | 4.8 |
| Nitrogen | 80.00 |
| | 100.00 |
| Or otherwise: | |
| Air | 72.38 |
| Carbonic acid | 4.80 |
| Nitrogen | 22.82 |
| | 100.00 |

Quantity of air passing into a furnace with the steam blast = 1.83 tons per hour. Temperature of the gases assumed to be the same as in a similar furnace at Oldham, viz., 2,000° Fahr.

But at Oldham about 7-16 of the total steam available is used in the steam blast; therefore over 32 I. HP. per cell is actually available, or 5½ I. HP. for twenty-four hours for every ton burnt, and that without feed-water heaters or expensive refinements in the engine. From the same figures it will be seen that 1 lb. of refuse will raise 2.13 lbs. of steam, as against about 10 lbs. of steam per pound of coal under similar conditions. In other words, the evaporative power of average coal is about 4.69 times that of ashbin refuse.

So much for the theory.

To turn to what is actually being done at Oldham, where the author, assisted by his brother, Mr. F. L. Watson, recently made careful measurements. For taking the temperatures, the following apparatus on the principle of the Siemens pyrometer was used. An ordinary iron bucket was cased all over with about 2 ins. of slag wool or silicate cotton, the cover for the top being movable. A thermometer was hung over the side of the bucket, dipping in about two gallons of water, less or more, weighed for each experiment. Pieces of wrought iron from 4½ to 5½ lbs. weight were used, and it was found that the loss of weight by oxidization was negligible even for several successive experiments with the same piece. The loss of heat by radiation from the bucket was also negligible, being at 120° Fahr. only 1° in fifteen minutes, whereas the maximum temperature of the water, after the hot iron was put into it, was reached in less than five minutes. The method of using the instrument, as is well known, is to place a piece of metal (iron in this case, whose specific heat was taken at .1255) of known weight and specific gravity in the gases whose temperature is to be increased, and, when it has had time to reach the same temperature as the gases, to withdraw it and quickly place it in water of a known weight. The amount by which the temperature rises is a measure of the temperature of the iron before being placed in it.

The average temperature of the mattress chamber through which the hot gases pass on their way to the boiler was found to be 2,019° Fahr., the minimum being 1,654° Fahr., and the maximum 2,346° Fahr. The above results are confirmed by the melting of three pieces of cast iron, of which the melting point was not less than 2,100° Fahr. in one of the fires.

The temperature of the gases as they escaped from the boiler flues was also measured, and found to be 855° Fahr., but since the iron could only be hung in front of the opening to the large dust chamber where the gases must have already expanded and cooled considerably, it will be quite safe to assume that the temperature on leaving the boiler was not less than 900° Fahr. The boiler is multitubular, 7 ft. in diameter by 12 ft. long, and is fed through a new Kennedy's patent water-meter, which was used for measuring the water in the evaporative trials. The first trial extended over four hours on June 23, the boiler water gage being marked and the water brought back to the same level at the end of the test. The second trial was held the following day for six hours, and the average evaporation for the two trials was found to be 278 gallons per hour.

The steam used by the steam jets was ascertained by means of a two hours' test and was found to be equivalent to 150 gallons of water per hour.

The boiler room being quite inadequate, it is fair to assume that with another boiler the gases could be reduced in temperature 200° lower or down to 700° Fahr., while at the same time relieving the first boiler of its excess of output (which no doubt caused priming), and therefore the actual evaporative power may be put at 328 gallons per hour. Deducting the 150 gallons for the steam jets we have 178 gallons, or 1,780 lbs. of steam at 70 lbs. pressure per sq. in. per hour available for use, which would be equivalent to 89 I. HP. from the six cells burning 1½ tons of refuse. That is about 15 I. HP. per cell, as against 32 I. HP. which was found to be the theoretical amount.

The Oldham plant was not laid out in such a manner as to insure the maximum steam-raising capacity, and the author has no doubt at all that with certain improvements a much better result may be obtained, and one much nearer to the theoretical amount, which was based on a fair efficiency of the plant. But, even supposing the power at present available to be utilized and valued at 1d. per I. HP., per hour, we have 1s. 3d. per hour per cell burning ¼ ton of refuse per hour, or, equal to 5s. per ton burnt. At Oldham the cost of burning is 1s. 10d. per ton without counting any returns from sale of mortar, etc., and including all charges. It does not include the cost of collection, which may be taken at 2s. per ton. Then, we have 1s. 2d. per ton as the net value of the refuse as it lies at the house of the producer.

To turn for a moment to the case of London with its 4,221,000 inhabitants. Take the total refuse as 500 tons per annum per 1,000 inhabitants, and suppose the destructors to work as they ought, every day of the week. Then 750 cells, costing (at, say, £500 per cell) £375,000, would more than suffice to burn the whole. From these 15,000 I. HP. could be made available night and day, if the plant were laid out for the purpose.

Or, to look at the question in another way. The sludge fleet barges carry away 20,000 tons of sludge per week, or, say, 2,800 tons per day. If there were added to this two-thirds the quantity, or, say, 1,910 tons of ashbin and other refuse, then 600 cells, costing £300,000, would suffice to burn the whole; while 12,000 I. HP. could be made available at the outfall works, and at least 70% of it in the city. The results at Rome and Frankfort from long distance currents amply justify this statement.

The clinker resulting from this system of burning at a high temperature, is about 22.5% by weight of the refuse, and the fine ash 10.5%, making, together, 33% by weight, weight and 25% by bulk. The clinker is valuable in any part of the country, and can be used for a great variety of purposes, and the fine dust from the flues makes a good basis for disinfecting powder if treated with carbolic acid. The ashes are also useful for many purposes.

Destructors should always be placed with a view to saving in cartage, and it will be probably found that they will answer best in groups of four to six cells. The nuisance of continual carting to larger destructors is a great hardship to those who live on the main roads to them.

Even in large villages the destructors may be successfully applied. The sanitary condition of many small towns and villages is known to be often worse by far than that of the large towns, for there is often no system either of collection or disposal of refuse. The destructor would also provide the luxury of light, where it would be otherwise out of the question.

The author feels the shortcomings of this paper; and that his efforts are very little worthy of this great subject of refuse disposal, which is engaging attention in every part of the civilized world. It has been ably discussed within the last few days by the British Medical Association, and by the Institution of Mechanical Engineers. In Russia, sanitary reform admits of no delay, and it is shocking to read of the state of things in that backward country in view of the present terrible visitation of cholera. Even in this country, which leads the world in such matters, the sewage, or rather the refuse, question, is by no means settled, as the author hopes he has shown, by the adoption of the water carriage system with its huge expense, and all its drawbacks, of which the greatest is that it is not a system of disposal at all. Scandalous maladministration still exists; and, amid the storm of political strife it appears to pass unnoticed.

If, by calling attention to the subject, and by leading to discussion by this great Association, this paper should indirectly help forward the cause of the health and happiness of the masses of the people ever so little, it will not have been labor unrewarded.

* Paper by W. B. G. Bennett, M. Inst. C. E., Proceedings of the Institution of Civil Engineers, vol. lxxxviii., page 181.

** "Times," March 17, 1892.

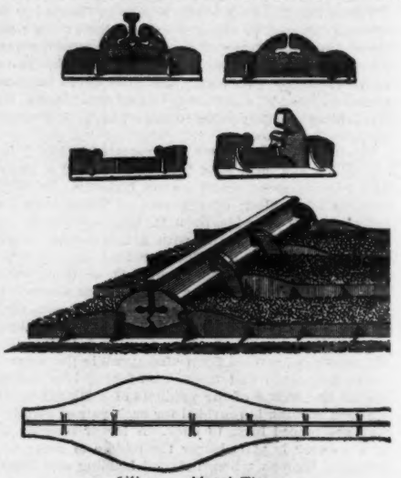
## A DIRECT POSITIVE BLACK PRINT PAPER.

Most engineers have felt the necessity for a simple method of reproduction that will give black lines on a white ground from an ordinary tracing; that is to say, for a direct positive printing paper. Such a paper has been recently tested in this office with excellent results. When properly handled it gives a purple black line on a white ground, while improperly timed exposure will leave the ground more or less violet in color or weaken the lines. Most if not all other positive printing processes require developing after printing. This process, however, is very simple. As in the case of ordinary blue prints the paper is exposed in a frame for 10 minutes or so (until the ground is white) and then taken out and thoroughly washed in clean water, which washing fixes the print.

The makers claim that the paper, if carefully wrapped up, will keep for a long time (even six months or so) without deterioration. It is sold, ready prepared in rolls, by Messrs, Schwenke, Kirk & Co., 26 Church St., New York.

## KINNEAR'S METAL TIE.

Metal ties for railways are the subject of a great many patents, the design being in general more or less impracticable for the reason that the majority originate with persons who are by no means familiar with track work and the requirements of track. The tie patented by Mr. W. R. Kinnear, of the Kinnear & Gager Company, Columbus, O., and illustrated herewith, has some novel features in its device for the rail fastening, but does not seem to us to commend itself for practical service. The



Kinnear Metal Tie

tie is of tee section, with the width of base and height of web increased at the rail seat and having several fillets connecting the flat base and web. It is weakened, however, by cutting away the material at the rail seat to fit the movable rail chairs, which straddle the web and bear against the rounded projections. The chairs are narrow and give but a small and insufficient bearing to the base of the rail. This chair is intended to give an automatic clutch grip upon the rail, the depression of the rail under the weight of a train causing the two parts to turn on the projections of the web of the tie and thus bear tightly on the web and base of the rail. There is nothing, however, to prevent the rail from rising to its former position when the train has passed, so that there would be a considerable rattling and pounding of the track, and rapid wear of the bearing surfaces. The narrowness and motion of the parts upon which the base of the rail rests, would almost certainly result in a very severe cutting and wear of the rail. The inventor states that the clutch can be locked by a taper pin driven through the lower part and the web of the tie, and that adjustment of gage can be effected by the use of special sized clutches, but the use of such special parts is a decided objection in track work. The principle upon which the fastening is designed is ingenious, but the arrangement is certainly not promising for railway track.

## THE EQUATIONER.

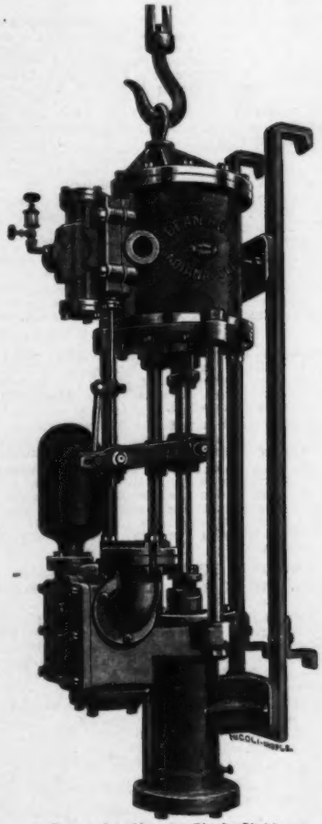
The instrument shown in the accompanying cut is nothing more nor less than a circular slide rule, the circular scale being a little over 5 ins. in diameter, and consequently the equivalent of a straight slide-rule about 16 ins. long, or nearly twice the length of the ordinary slide-rule, with the further advantages that the reading glass mounted above the scale enables the readings to be more accurate.

The Equationer.

We have so often recommended the more general use of the slide rule that we need not say we approve of any form of it. This particular form of it was designed by Mr. Walter Hart, and is sold by the Equationer Company, of New York. We think it probable that a good many men may find it easier to use a circular than a straight slide-rule; either is easy enough to use.

### THE DEAN VERTICAL SINKING PUMP.

We show herewith a very convenient style of steam pump, designed especially for work in shafts, mines, wells, quarries or pits. For reclaiming flooded mines or tunnel shafts it is especially adapted, and may be conveniently used in any place where a portable pump is required. By using a flexible steam pipe connection it can be suspended by a chain and lowered down the shaft as fast as the water recedes, stopping only when it becomes necessary to add a new length to the steam pipe. As it is a single-cylinder pump it



A Pump for Use in Shaft Sinking.

occupies very little space, and is especially adapted to underground work in emptying sumps, etc. The pump illustrated has 14-in. steam cylinder and 8-in. water cylinder with 12-in. stroke. The suction is made for 6-in. pipe and the discharge for 5-in. A variety of sizes, however, is furnished by the builders. The valve-gear is of the Dean noisless pattern with adjustable stroke. When so ordered the water cylinder is lined with gun metal to resist the corrosion of foul water. The pump is made by Dean Bros., of Indianapolis.

### DESIGNS FOR STRUCTURES ON THE NEW YORK RAPID TRANSIT RAILROAD.
(With inset.)

We illustrate this week some of the principal structures designed for the New York City Rapid Transit Railroad by the engineering staff of the Commission. That of principal interest is the viaduct carrying the line across the Manhattan Valley with the station at Manhattan St. The viaduct is a plate girder structure supported on columns, with spans alternately 30 and 60 ft. in length. A light riveted bracing is fastened to the under side of the girder, as illustrated, and gives the spans a more pleasing outline. From 125th St. to 126th St. a solid masonry approach is shown, and 125th St. is crossed by a braced arch of low rise. As the station platform at Manhattan St. is about 55 ft. above the street level, elevators are provided. As this is an express station the passenger platforms have to be located on each side of the center tracks, while at the bottom elevator shafts are confined to the center of the boulevard. This makes an inclined shaft for the elevators necessary, but its construction although unusual seems to offer no especial difficulty.

The highest structure on the line, be believe, is the viaduct across Sherman Creek, an arm of the Harlem River about a mile north of the Washington Bridge. The design is for a structure with plate girder spans supported on braced piers according to the present usual practice in iron trestle construction. We also show a standard design for double track viaduct on open streets, which is quite similar to the best class of elevated railway works, that has been erected within recent years. Of course the drawings shown are only intended to show the general outlines of the proposed structures. The requirement that all structures shall be proportioned to carry with safety as great a load as that provided for on first-class standard gage passenger railways should secure ample strength and solidity for the structures illustrated.

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The total number of great guns required for vessels now authorized is 381, says Commodore Folger, in his annual report as Chief of the Bureau of Ordnance, to the Navy Department. Of this number 237 of various calibers have been completed, and 116 are afloat. For the secondary batteries of ships 291 rapid-firing and machine guns have been furnished, and 168 are afloat. Since the date of his last report 1,500 lbs. of smokeless powder have been made and tested with gratifying results. Repeated experiments demonstrate the safety and stability of American powder of this class, and its superiority over published reports of tests of foreign powder made abroad. It has higher and more regular velocity, with lower and more uniform pressure. Dupont & Co., of Wilmington, Del., have completed their gun-cotton factory, and they have delivered 20,000 lbs. out of the 50,000 lbs. ordered by the government.

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A fast run on the Philadelphia & Reading R. R. was made Nov. 22, between Philadelphia and New York. The engine was a Vauclain four-cylinder compound engine, one of five built by the Baldwin Locomotive Works for express service on the Central R. R. of New Jersey and had a train of four cars. Near Fanwood, N. J., a mile was made in 37 seconds and the next mile in 38 seconds, according to press dispatches, the speeds being 97.3 and 94.73 miles per hour respectively. These are the highest speeds on record, the previous records having been a mile in 39.5 seconds, 91.14 miles per hour, on the Central R. R. of New Jersey, Feb. 26, 1892 (Eng. News, June 9, 1892); and a mile in 39.8 seconds, 90.5 miles per hour, with an engine and car on the Philadelphia & Reading R. R., Aug. 5, 1891 (Eng. News, Sept. 12, 1891).

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The improvement of the navigable channels of the Great Lakes, now authorized by Congress, involves the expenditure of $3,340,000. Work must commence by May 15, 1893, and it must be finished in three working seasons. The various projects include the cutting of channels 21 ft. deep and 300 ft. to 650 ft. bottom width through various shoals in the St. Mary's River, Mich., through small shoals at the foot of Lake Huron, and the improvement of the St. Clair flats, Mich. The total estimated excavation is about 2,400,000 cu. yds.

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The waterways of France, says the London "Times," have a total length of 7,995 miles, of which 2,735 miles were rivers navigable naturally, 2,250 miles rivers which had been rendered navigable by dredging, and the rest canals. The total quantity of goods carried upon these waterways last year was 25,181,056 tons, or 1,013,713 tons more than in 1890, the increase in the traffic being much greater on the canals than the rivers. The international water traffic between France on the one hand and Belgium and Germany upon the other was 3,012,637 tons, of which 2,125,407 tons were imports and 887,230 tons exports. More than 50% of the imports consist of combustibles brought from the coalfields of Mons and Charleroi, while the exports are almost entirely composed of goods sent to Belgium.

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The city of Berlin intends to include among its exhibits at the World's Columbian Exposition some technical exhibits, consisting of models and drawings of correction of the Spree River; the principal modern bridges; the new waterworks on Lake Mueggel, the city hospital; the asylums; the municipal gas works; the city's sewerage system; the central and local markets; the municipal abattoirs and public baths in Moabit. The estimated cost of the exhibits mentioned will be $6,775. The necessary space will be 918 sq. ft. of wall space and 216 sq. ft. of floor space.

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Immigration was and is by no means wholly stopped, despite the quarantine embargo. The immigration was in

| | 1892. | 1891. |
|---|---|---|
| September | 28,229 | 52,706 |
| October | 16,428 | 54,182 |

The immigration from Bohemia, Austria Hungary, Poland and Italy, however, has almost wholly stopped, and that from Germany decreased to less than one-third of what it was.

## CONSTRUCTION NEWS.

### RAILWAYS.

#### East of Chicago.—Existing Roads.

CONNEAUT TERMINAL.—This company has been chartered in Ohio in the interest of the Pittsburg, Shenango & Lake Erie R. R. to build a terminal railway at Conneaut, O. Among the incorporators are: Samuel B. Dick, Meadville, Pa., Allen M. Cox, Conneaut, O., and Thos. H. Wells, Youngstown, O.

SINNEMAHONING VALLEY.—The Buffalo, N. Y., "Express" says: "The Sinnemahoning Valley R. R., the line running through the Potter Co., Pa., lumber possessions of Frank H. Goodyear, is being extended rapidly from Castello to Galeton, where a connection will be made with the Addison & Pennsylvania, which is a branch of the New York, Lake Erie & Western R. R. It is expected that the line will be ready for use by next spring, thus giving to the Sinnemahoning a fine outlet for its lumber to the east. The extension is about 23 miles long. It is likely the new line will be used for the handling of soft coal to interior New York points."

RAPID RIVER & EASTERN.—This company, which was chartered last August to build a railway from Torch River to Kaikaskia, Mich., has completed one mile of its line.

SANDUSKY & COLUMBUS SHORT LINE.—Tracklaying has been completed from Sandusky to Delaware, O., or within about 22 miles of Columbus, O.

PHILADELPHIA & READING.—Surveys are to be made soon for a line from Five Forks, Pa., to East Hagerstown, Md.—Surveys are also in progress for a line from Kalmia, Pa., to a connection with the Williams Valley R. R., near Williamstown, Pa. The object of the line is to open up several thousand acres of timber land owned by the company.—It is announced that surveys have been begun for the proposed new line to Cape May, N. J., and other New Jersey coast resorts. The line as projected will run from Landisville, N. J., via the Delaware Bay shore, to Cape May, with branches to Ocean City, Sea Isle City and Five Mile Beach. The line will be very easy to construct.

STATEN ISLAND RAPID TRANSIT.—Bids will soon be opened for the construction of an extension from Ft. Wadsworth to the seashore, to cost from $100,000 to $125,000.

PENNSYLVANIA.—It is announced that a line will be built from Newark, N. J., to the Oranges and thence to Milburn, Springfield and Scotch Plains, to Plainfield, N. J.—This company, it is stated, has decided to rebuild the old Egg Harbor-Mays Landing branch and has already begun work.—The report is confirmed that the branch from William Penn, Pa., to Mt. Carmel, Pa., will be built at once.—At a meeting of the Road Committee of the company held recently, $2,000,000 was ordered to be expended for the addition of third and fourth tracks and the enlargement of the bridges on the Philadelphia and Middle divisions. Nothing was done towards making any improvements on the Pittsburgh division, but it is understood that the division will receive the same attention later on.

#### Projects and Surveys.

TURBOTVILLE & WILLIAMSPORT.—Chartered in Pennsylvania to build a railway from Turbotville, Northumberland Co., to Newberry Junc., near Williamsport, Pa., a distance of about 30 miles. Pres., Rudolph T. McCabe, New York City.

DANBURY & STATE LINE.—Chartered in Connecticut to build a railway from Danbury, Conn., to a point on the state line in the town of Ridgefield, a distance of 6 miles. Among the incorporators are: E. M. Barnum, J. W. Ives and Wm. Beckertee, of Danbury, Conn., and Edward Smith and Henry Blake, of New York City.

INDIANAPOLIS, LOGANSPORT & CHICAGO.—The right of way is reported secured and capital obtained for the construction of this railway from Indianapolis to Hammond, Ind.

#### Southern.—Existing Roads.

MARIETTA & NORTH GEORGIA.—The Atlanta, Ga., "Journal" publishes an article to the effect that the Marietta & North Georgia R. R. will be reorganized and extended to Atlanta. It says that the Post Committee consisting of H. A. V. Post, of New York; Thomas Carmichael, of London; Newman Erb, of Kansas City; Walter Stanton, of New York, and E. E. Dennison, of Philadelphia, have secured a majority of the bonds, and that the road will be consolidated with the Knoxville, Cumberland Gap & Louisville R. R. The latter road will be extended from a point near Tate Springs, Tenn., to the Norfolk & Western R. R. A line will be built from a point near Twin City, on the Marietta & North Georgia to Chattanooga. It is expected that the line will be amalgamated with the Chattanooga Southern R. R., which latter line will be extended from Gadsden, Ala., to Birmingham. The line will then touch the four great Southern cities of Atlanta, Chattanooga, Birmingham, and Knoxville, and traverse exceedingly valuable mineral and timber lands.

WEST VIRGINIA CENTRAL & PITTSBURG.—A press dispatch says: "The West Virginia Central Railroad Co. has abandoned the proposed extreme Eastern route for the extension of its lines to tidewater. The preliminary survey had been completed, but the engineer's report showed that the irregularities of the country render the construction of the line impracticable. The route along the Potomac River, though a longer one, will probably be taken, unless the company can make some arrangement with the city of Baltimore for the

Western Maryland Road. The West Virgiia Central's proposition has never been rejected, but the opposition raised by the public to the proposed deal caused the City Council to appoint a commission to inquire into the financial standing of the Western Maryland. When the commission reports the West Virginia Central will likely press its bid for the road.

WINNSTON & BONE VALLEY.—Pres., J. E. Griffin, Winnston, Fla., reports that this company hopes to get started within a year on the work of extending its road. The line is now completed between Winnston and Phosphoria, a distance of 21 miles, and is projected from the latter point in a southwesterly direction through Polk, Hillsboro and Manatee counties to a point at or near the Manatee River. The entire length of the road will be about 60 miles.

CHESAPEAKE & OHIO.—About 5 miles of track have been laid on the Buckingham R. R. from Avonia to Rosney, Va., 16¾ miles.

STILLMORE AIR LINE.—The "Manufacturers' Record" says: "The Stillmore Air Line Ry. Co. has been incorporated, with George M. Brinson, Pres.; Thomas S. Wylly, Jr., of Savannah, Vice- Pres., and H. J. Biddenbach, of Stillmore, Sec. and Treas. The company will complete the railroad previously reported as being built by Mr. Brinson. The road will run from Collins, on the Savannah, Americus & Montgomery, via Stillmore to Swainsboro, Ga. Ten miles of the line are in operation, and 300 hands are at work grading the remainder. It is understood that financial arrangements have been perfected for completing the road, and it is expected that the work will be finished in January next.

### Northwest.—Existing Roads.

GREEN BAY, WINONA & ST. PAUL.—At a recent meeting of the directors of the Green Bay, St. Paul & Minneapolis R. R. Co., the following officers were elected: Pres., Jos. Walker, Jr., Vice-Pres., and Gen. Man., S. W. Champion, and Secy. and Treas., W. J. Abrams. This is the name under which the extension of the Green Bay, Winona & St. Paul R. R. will be extended to St. Paul, Minn., and at the meeting the various routes for the line were considered. No decision was arrived at, however, except that the termini should be at Merrillon Junc., Wis., and St. Paul.

ST. LOUIS, ALTON & SPRINGFIELD.—Work has been commenced on the line from Alton to Kindar, Ill., 15½ miles. It is stated that rails are being distributed along the right of way at the rate of ten car loads per day.

SIOUX FALLS, YANKTON & WESTERN.—Contractors are now at work along the entire line from Sioux Falls, S. Dak., to Yankton, S. Dak. The route is from the terminus of the Sioux Falls Terminal R. R., seven miles southwest of that town and via Lennor and Volin, to Yankton. Pres., Melvin Grigsby, Sioux Falls, S. Dak.

### Southwest.—Existing Roads.

PINE BLUFF & EASTERN.—Work is rapidly progressing on the extension to English, Ark., 3 miles, and is expected to begin soon on a continuation of the line.

NORTH GALVESTON, HOUSTON & KANSAS CITY.—About 6 miles of track are reported laid on this line from Virginia Point to North Galveston, Tex., 17 miles. About 45 teams are now grading and the contract has been let for the ballasting.

MISSOURI, KANSAS & TEXAS.—Plans are being made to float about $5,000,000 of improvement bonds.—A loan is reported to have been negotiated to provide for an extension from Coffeyville, Kan., across Indian Territory to Vernon, Tex., about 300 miles. It is stated that this line will be located this winter and that construction will begin in the spring of 1893.

CHICAGO, ROCK ISLAND & PACIFIC.—The engineers of this company are preparing to continue the surveys of its southern extension from Bowie to Fort Worth, Tex., Tracklaying between Bowie and the Red River is progressing rapidly.

TEXAS & SABINE VALLEY.—This railway, which is projected to run from Carthage, Tex., via Tenaha, to Center, Shelby Co., Tex., 30 miles, will be operated as an extension of the Texas, Sabine Valley & Northwestern R. R. Only two miles of the line have been surveyed and it is expected to have this in operation by Jan. 1, 1893. The route is through a rolling prairie country affording easy work; maximum grade 1% and maximum curve 3°. Pres., Edwin S. Larchar, 15 Wall St., New York City; Ch. Engr., Richard J. Evans, Longview, Tex.

### Projects and Surveys.

NATCHEZ, ALEXANDRIA & TEXAS.—The surveys have been completed from Alexandria, La., to the Sabine River, 73 miles. Ch. Engr., C. W. Salter, Alexandria, La.

### Rocky Mt. and Pacific.—Existing Roads.

ATCHISON, TOPEKA & SANTA FE.—A press dispatch from San Francisco, Cal., says: "A mortgage of the San Francisco & San Joaquin Valley R. R. property, filed this week at Antioch, to Baring Bros., of London, marks an important step in securing competing railroad facilities for this city. This property of 1,300 acres was bought several years ago by I. H. Wilbur. The deed was made in his name, but " was understood he acted for the new railroad. The new tract included three miles of frontage on the bay and the San Joaquin River, and it was to be the terminus of the San Joaquin Valley road, which in turn would furnish the Santa Fe road its desired outlet to tidewater. .When the Baring failure came all work on the San Joaquin Valley road stopped. Only 14 miles were built, but the surveys carried it through the Tejon Pass to connect with the Atlantic & Pacific. About the time that the Barings failed, Minot, the man who built the Great Northern by electric light and who had been in charge of the San Joaquin road, was killed in a railroad collision. Two weeks ago the Antioch property, which Wilbur had held, was transferred to Frank E. Peabody, of Kidder, Peabody & Co., of Boston, the financial agents of the Santa Fe. This week he mortgaged the property to the Barings, apparently to secure funds to begin building the road. The Santa Fe has a contract which compels it to give three years' notice of a desire to end its agreement with the Southern Pacific. With this new road to fall back on, a notice of this sort may soon be expected."

COOS BAY, ROSEBURG & EASTERN.—In a recent interview relating to the progress of work on this Oregon railway, contractor R. A. Graham, is reported as saying: "We now have 18 miles of the road in operation and have between 70 and 80 miles under contract. Next spring we shall push the road rapidly ahead to a junction with the Southern Pacific at Roseburg. Meanwhile ties will be taken out and all possible preparations made for laying the rest of the track. This task will keep a large force busy during the winter. So far as I can foresee, next fall will find trains running between Roseburg and tidewater. The road will not run from Empire City, the county seat of Coos Co., although that place is on the bay. Marshfield has been chosen as our tidewater depot, and it promises to become a good town. The Government is using an appropriation of $220,000 for the improvement of Coos Bay and has secured 18 ft. of water on the bar. By adding a little to what nature has done the Government can transform the bay to one of the best harbors on the coast."

NORTHERN PACIFIC.—Surveys are reported in progress for a line from the Seattle, Lake Shore & Eastern R. R. to Fairhaven, Wash.

CHICAGO, ROCK ISLAND & PACIFIC.—Preliminary surveys are reported completed for an extension from Limon, Colo, to Castle Rock, Colo.

COLORADO MIDLAND.—Rapid progress is being made on the branch from near Summit Park, Colo., to the Cripple Creek mining region, 16 miles. It is expected to have the work completed in about three months.

UNION PACIFIC.—The Red River branch near Trinidad will be extended next spring about 10 miles down the Red River. This branch is now about three miles long, and branches off from the Maxwell branch at Catskill, 25 miles southwest of Trinidad, Colo.

NORTHERN PACIFIC.—Trains on the Chehalis-South Bend branch, are now running to Holcomb, Wash., 45 miles from Chehalis. Grading has been pushed on the whole line, and only about 7 miles more of track remain to be laid.

DENVER & RIO GRANDE.—It is announced that contracts will soon be let for the proposed line to the Irwin coal fields. The line is to be called the Ruby Anthracite Branch.

CANADIAN PACIFIC.—The Columbia & Kootenai Ry. Co., will apply at the next session of the Canadian Parliament for power to extend its line now in operation from Robson to Nelson, B. C., to Ravelstoke, B. C.

### Projects and Surveys.

ASTORIA & EASTERN.—Chartered in Oregon to build a railway. Capital stock, $,3000,000.

### Foreign.

MEXICAN NATIONAL.—A press dispatch from Monterey, Mex., says: "There is much rejoicing here today over the authoritative announcement that the Mexican International Ry. system is to be extended to this city. Engineers are now in the field running the survey of the proposed route from Espinoso to Monterey. C. P. Huntington, President of the Southern Pacific and Mexican International companies, has been for some time contemplating building an independent line to Monterey, and upon his recent visit to Mexico he made a thorough investigation into the feasibility and desirability of the project, with the result that he decided to undertake the work without further delay. It is believed here that the line will be extended to Tampico ultimately."

### ELECTRIC RAILWAYS.

MONSON, MASS.—The Eastern Hampden Street Ry. Co. is being organized, with a capital stock of $60,00, to build a line to Ludlow, with three branches. A. M. Young, of Waterbury, Conn., and R. S. Hicks, of Stafford Springs, Conn., are interested.

BROOKLYN, N. Y.—The Kings County Electric Ry. Co. has been incorporated, with a capital of $625,000 to construct about 16 miles of surface road. The terminal points are the 39th St. ferry and Union St., and the city line in the 28th Ward; also Cooper Ave. and the city line in the 18th Ward. The principal office of the company will be at New Utrecht. The directors are: James F. Casey, Albany; Michael Bergen, Paterson, N. J.; Frank O'Rorke, George J. Bryan, George Damen, James W. Knox, and P. H. Flynn, of Brooklyn; Joseph E. Sullivan and James Jackson, of New York, N. Y.

NEW YORK, N. Y.—The Waddell-Entz Electric Co. will run ten of its storage battery cars on the Second Ave. surface line next year.

MECHANICVILLE, N. Y.—The Stillwater & Mechanicville Street Ry. is to be equipped for electric traction, and the track is to be rebuilt. D. Powers & Sons, of Lansingburg, are interested, and Mr. Clothier is the engineer.

MOUNT VERNON, N. Y.—The Mount Vernon & New York Ry. Co. has been incorporated, with a capital of $100,000, for constructing a street surface railway from Mount Vernon to New York City. The directors are Franklin A. Wilcox and John H. Eden, of New York; Charles B. Hobbs and John R. Benner, Jr., of Brooklyn, and George W. Bard, John E. Bryant, Henry V. Morgan, Stuart V. Morgan, Stuart W. Cowan, and Joseph F. Wood, of Mount Vernon.

CORNING, N. Y.—The Citizens' Electric Ry. Co. has been organized to build a line to Painted Post, 6 miles. The capital stock is $100,000, and among the incorporators are H. H. Hungerford, Frederick Swift and John A. Seeley, of New York.

FORT RICHMOND, N. Y.—The Electric Railway & Improvement Co. of Staten Island has been organized in Jersey City, N. J., by J. F. Ward, of Jersey City; T. W. Greene, of New Brighton, N. Y., and L. Semple, of New York, N. Y.

ATLANTIC CITY, N. J.—An electric railway is to be built to Somers' Point. John B. Chapman is interested.

LOUISVILLE, KY.—The Kentucky & Indiana Bridge Co. proposes to use electric motors instead of steam engines for the suburban trains to New Albany, Ind., and Parkland.

CHICAGO, ILL.—The Calumet Electric Ry. Co. has secured a loan of $1,000,000 from the Title Guarantee & Trust Co., of Chicago, with which to extend and improve the system.

KIRKWOOD, MO.—The Kirkwood, Webster Grove & St. Louis Electric Ry. Co. will build a double-track trolley line, with 60-lb. rails and 2,625 ties per mile. A contract has been awarded to the Heman Construction Co., of St. Louis, Mo.

SACRAMENTO, CAL.—The Sacramento Electric Power & Light Co. has been applied to the Sacramento Trustees for a franchise to conduct and operate an electric railway.

SAN JOSE, CAL.—The city trustees have passed an ordinance granting to Messrs. Burke and Henry a franchise for an electric road.

GALVESTON, TEX.—The South Galveston & Gulf Shore Ry. Co. has its line partly graded, and 250 tons of steel rails have been received. Ten motors have been ordered, and the car house, 130 × 160 ft., is being built.

### CABLE AND ELEVATED RAILWAYS.

NEW YORK, N. Y.—There is talk of the Manhattan Ry. Co. extending the Suburban Rapid Transit line from Tremont Ave. to Fordham.

CHICAGO, ILL.—The Lake Street elevated railway is said to have been bought out by a syndicate, which intends to push construction. The South Side Rapid Transit Ry. Co. has decided upon a route for a down town loop on Congress, Lake, Clark and Jackson Sts. A number of additional engines and cars have been built, and special cars are to be built for the World's Columbian Exposition traffic.

SIOUX CITY, IA.—The cable railway is to be double tracked on Jackson St.

### HORSE AND MOTOR RAILWAYS.

GRAVESEND, N. Y.—The Sheepshead Bay & Coney Island Ry. Co. has been incorporated with a capital stock of $250,000, by S. S. Williamson, Anson M. Stratton and W. J. Gladding.

POUGHKEEPSIE, N. Y.—The Poughkeepsie & Wappinger's Falls Street Surface Ry. Co. has been incorporated, with a capital of $100,000, for the purpose of constructing a road about ten miles in length, from Poughkeepsie to Wappinger's Falls, with branches to the Hudson River Driving Park and Vassar College. The directors are John P. Wilson, James W. Hinckley, Thomas J. Swift, Peter B. Hoyt, Frederick Barnard, L. H. Vail, and T. F. Lawlor, of Poughkeepsie, and H. F. Walcott, of Fishkill.

MILLVILLE, N. J.—Millville Rapid Transit Co.; $50,000; H. Mulford, J. B. Langley, and M. Ludlam, of Millville; E. V. Douglas, of Philadelphia, Pa.

BRIDGETON, N. J.—Bridgeton Rapid Transit Co $100,000; T. W. Harris and W. O. Garrison, of Bridgeton; E. V. Douglas, of Philadelphia, Pa.

JEANETTE, PA.—Jeanette & Penn St. Ry. Co; $30,000; with $3,000 paid in; to run from Jeanette to Pittsburg; Pres., George Wagner, Jeanette.

LEAVENWORTH, KAN.—Work has been commenced on the new compressed air railway. The rails will be supplied by the Illinois Steel Co., of Chicago.

### HIGHWAYS.

IOWA.—The Drury Toll Road Co. has been incorporated to build a road from Muscatine to the Illinois state line, by Chester Lillibridge, T. S. Stewart and Henry Jayne; capital stock, $50,000. There will be a bridge over the Mississippi.

CALIFORNIA.—A highway with two bridges of 250-ft. span is to be built between La Canada and Pasadena. Captain Dunham, of La Canada, is interested.

TEXAS.—The grand jury, at Dallas, Tex., has pointed out the importance of improving the public roads of Dallas Co., and recommends that road construction be done under a competent engineer, and that steps be at once taken to macadamize four highways intersecting at right angles in the city, and extending to the county boundaries.

### BRIDGES, TUNNELS AND CANALS.

WATERPORT, N. Y.—A bridge to cost $10,000 is to be built at this place.

BALTIMORE, MD.—Bids will be received until Dec. 5 for removing the present bridge over Jones Falls on Baltimore St., and building a new structure in its place. The new bridge will have a 40-ft. roadway, and two 13-ft. side walks and is estimated to cost $87,000. Cy. Engr., F. H. Smith.

LANSING, MICH.—The following bids were received for the Franklin St. bridge on Nov. 21:

| Name of Bidder. | Bid A. | Bid B. | Bid C. |
|---|---|---|---|
| Columbus Bridge Co., Columbus, O. | $18,800 | $16,900 | $1,160 |
| New Jersey S. & I. Works, Trenton, N. J. | 19,500 | 17,200 | 1,250 |
| King Bridge Co., Cleveland, O. | 18,900 | 16,900 | 1,100 |
| F. J. P. Brackett Bridge Co., Cincinnati, O. | 19,000 | 17,000 | 1,200 |
| Penn Bridge Co., Beaver Falls, Pa. | 19,908 | 18,908 | 1,725 |
| Variety Iron Works, Cleveland, O. | 19,500 | 17,000 | 1,890 |
| Jackson Bridge Co., Jackson, Mich. | 18,800 | 16,800 | 1,100 |
| Toledo Bridge Co, Toledo, O. | 19,672 | 17,000 | 1,300 |
| Wrought Iron Bridge Co., Canton, O. | 18,100 | 16,200 | 850 |
| Detroit Bridge & Iron Works, Detroit, Mich. | 21,000 | 19,000 | 2,000 |
| Iron Substructure Co., Columbus, O. | 21,200 | 20,200 | 1,400 |
| Youngstown Bridge Co., Youngstown, O. | 20,200 | 18,500 | 2,200 |
| Massillon Bridge Co., Massillon, O. | 18,800 | 17,200 | 1,500 |

Bid A, 3-span plate girder 180 ft. long, 80 ft. wide over all. Bid B, 3-span plate girder 180 ft. long, 64 ft. wide over all. Bid C,removing present 2-span bridge built in 1876. The contract was awarded to the Wrought

MILWAUKEE, WIS.—Specifications are being prepared for the Menomonee Valley viaduct, to connect 16th St. and 11th Ave.

### WATER-WORKS.

#### New England.

AUBURN, ME.—Nov. 21, Councils passed an order offering the Auburn Aqueduct Co. $250,000 and interest since Sept. 19, 1891, for its works, in accordance with the appraisal of a commission.

CAMDEN, ME.—The town has appointed Johnson Knight, J. H. Montgomery and R. Robinson, a committee to investigate the standing of the town with the company, and the feasibility of a new system.

MEREDITH, N. H.—A vote on establishing works will be taken.

MEDFORD, MASS.—The people have voted to expend $50,000 for protecting, improving and enlarging the water supply, the cost to be met by giving notes; also to petition the legislature for authority to issue $300,000 of bonds for the enlargement of the supply.

PROVIDENCE, R. I.—Bids will be received until Dec. 13 for 1,136 tons (2,240 lbs.) of 4 to 12-in. cast iron pipe. R. E. Smith, Comr. Pub. Wks.

SOUTH NORWALK, CONN.—The people have voted to buy land and rights for a dam 43 ft. high and a storage reservoir on Silvermine River, just below the junction of the east and west branches of the river.

### Middle.

BINGHAMTON, N. Y.—The Water Commissioners are investigating filtration.

COLLEGE POINT, N. Y.—The Village Trustees are talking of putting up a stand-pipe.

GREENBUSH, N. Y.—It is reported that the company is to add a filtering plant at the pumping station.

LANCASTER, N. Y.—The Depew & Lancaster Water-Works Co. has been incorporated; $50,000.

MAYVILLE, N. Y.—The contract for building works was let Nov. 22 to Chandler Bros., Beaver Falls, Pa., for $16,750. The pumps will be put in by the Buffalo Steam Pump Co. There will be a stand-pipe.

SEA CLIFF, N. Y.—The Village Board has instructed Trustees W. W. Mershon and C. E. Edwards to investigate a water supply for fire protection.

SOUTHAMPTON, N. Y.—The Southampton Water-Works Co. has been incorporated; $50,000; directors, Salem H. Wales, New York; Edgar A. Hildreth, Edward A. Fordham, Southampton, and others.

TROY, N. Y.—Prof. W. P. Mason, Troy, has reported on the chemical and bacteriological qualities of proposed new water supplies, and recommends Quackenkill stream.

TROY, N. Y.—Prof. Wm. J. Raymond, Troy, and Elnathan Sweet, Greenbush, have been appointed engineers to make surveys and investigations for a new supply from the Poestenkill or Quackenkill streams.

DECKERTOWN, N. J.—Works next spring are talked of.

HOBOKEN, N. J.—The directors of the Hackensack Water Co., it is reported, have authorized the issuance of $3,000,000 5% 50-year gold bonds at 103 and interest, of which $1,200,000 will be issued in January and the remainder as needed. It is said that a new reservoir, 750 × 1,100 ft., will be built in West Hoboken, and that a new 18-in. force main is now being laid to supply the proposed reservoir.

ALTOONA, PA.—Mr. G. A. Martin, Secretary of the Department of Water, writes us that bids for the new reservoir will be received until Dec. 15 instead of Dec. 8, owing to the illness of the engineer in charge, C. W. Knight, of Rome, N. Y.

DICKSON CITY, PA.—The Throop Water Co. has been incorporated; $5,000; Treas., Clarence M. Sanderson.

McKEESPORT, PA.—Bids for two 3,000,000-gallon pumps are wanted until Dec. 6, as noted in detail last week.

HAGERSTOWN, MD.—The Council has ordered the company to add 16 hydrants.

LAUREL, MD.—It is said that Baltimore capitalists wish a franchise. The people voted against granting a franchise last April, but are thought to be less opposed to it now.

### Southern.

WILSON, N. C.—It is reported that J. L. Ludlow, Winston, will make surveys for works estimated to cost $60,000.

BARNESVILLE, GA.—A vote on establishing works will be taken.

CARTERSVILLE, GA.—F. M. Ford, Jas. Knight and J. I. M. Montgomery, have been appointed by the Council to obtain plans and estimates for works.

MONROE, LA.—The city has awarded a contract to Henry R. Worthington, of New York, for two pumps of 1,250,000 gallons daily capacity.

TUSCUMBIA, ALA.—A franchise is reported as granted to the Electric Light & Water-Works Co.

NEWPORT, KY.—The Suburban Supplying Co. has been incorporated to supply water, gas and electricity; $100,000; Jas. M. Glenn, Samuel Blugstaff and Jas. C. Wright.

### North Central.

CINCINNATI, O.—The Board of Administration will receive bids until Dec. 17 for one or two machines for tapping under pressure branches into water pipe of any size from 4 to 36-ins., the diameter of tap to be from 2 to 24-ins.

CLEVELAND, O.—An independent fire protection system, from the Kinsman St. reservoir, has been reported on by Supt. Kingsley; estimated cost, $114,348.

NEW PARIS, O.—The Cedar Springs Water Co. has been incorporated to supply Buckhaven, near this place; $50,000.

TIPTON, IND.—The Council is said to be discussing works, but is divided on the question of ownership.

BERLIN, WIS.—The Council has decided to submit the question of building works to the charter election next spring.

BUCHANAN, MICH.—The Council has accepted a proposition from Peter English to build works.

KENOSHA, WIS.—Dwiggins & Starbuck, Chicago, wish to put in works, with a supply pumped from the lake to a stand-pipe.

### Southwestern.

COLUMBIA, MO.—The Council has granted a franchise for water and electric lighting plants to W. T. Anderson, St. Louis, work to be commenced at once; estimated cost, $80,000 to $100,000.

CANYON, TEX.—The Canyon City Investment Co. has been incorporated to construct buildings, furnish water, gas and light to this place and Trinidad, Colo.

EL PASO, TEX.—Cy. Engr. Campbell has reported to the Council recommending city works, including 20 7-in. cased wells, a 3,000,000-gallon reservoir, a pumping plant and distribution system; estimated cost, $210,000 to $250,000.

MODESTO, CAL.—Nov. 19 the people voted $60,000 bonds for city works.

### Pacific.

WHATCOM, WASH.—It is reported that the people will vote on buying the Cornwall works for $150,000, and extending them at a cost of $100,000.

RODEO, CAL.—The Rodeo Water & Wharf Co. has been incorporated; $500,000.

SAN DIEGO, CAL.—Propositions for a new supply, the distribution system only, to be owned by the city, are being submitted.

SAN FRANCISCO, CAL.—It is reported that the Spring Valley Water Co. is likely to build a dam on Calaveras Creek, with a capacity of some 29,000,000,000 gallons.

VALLEJO, CAL.—J. H. Browne informs us that specifications for works are being prepared, and that bids will be soon asked. The supply will be by gravity from Green Valley Falls, 14 miles distant.

TUCSON, ARIZ.—P. J. Cole, Phoenix, has made a proposition to put in water-works and sewerage systems.

### Canada.

BUCKINGHAM, QUE.—The construction of works has been started.

BROCKVILLE, ONT.—Nov. 24, the people voted 701 to 26 to issue $150,000 of bonds to buy the works.

### ARTESIAN WELLS.

FROSTBURG, MD.—Engr. G. G. Townsend has been instructed to locate an 8-in. well.

### IRRIGATION.

GARDNER, WYO.—Oliver Olson, Salt Lake City, Utah, is interested in a project to irrigate a large tract of land here.

NEW COMPANIES.—Colorado Land, Irrigation & Power Co., Denver, Colo.; $100,000. Farmers' Drain & Irrigating Ditch Co., Greeley, Colo.; $10,000. Cache Valley Land & Canal Co., Ogden, Utah; $1,000,000; Rufus H. Whipple, Theodore Robinson and others.

### SEWERS.

NEWTON, MASS.—The City Treasurer has been authorized to borrow $119,000 for the construction of sewers.

WALTHAM, MASS.—The Board of Aldermen has voted to extend sewers in two streets.

WORCESTER, MASS.—The City Engineer is preparing plans for the disposal of the sewage at the poor farm. Downward intermittent filtration is recommended.

WALLINGFORD, CONN.—At a special borough meeting Nov. 22, an appropriation of $8,000 was voted for a sewer in Meadow St.

BROOKLYN, N. Y.—The Commissioner of City Works will receive bids until Dec. 5 for three lateral sewers.

FORT PLAIN, N. Y.—Plans for a sewerage system for the entire village have been prepared by DeWitt C. Smith, Cy. Engr., Schnectady. The estimated cost is $22,000. As soon as the plans have been approved by the State Board of Health, a special election will be held to decide the question of construction. D. G. Hackney and E. A. Allen are members of the recently appointed sewer commission.

GENEVA, N. Y.—A sewer commission has been organized, and J. J. R. Croes has been asked to submit plans and estimates for important extensions of sewers. Mr. Croes prepared plans in 1883 for a complete system, which at that time was considered too extensive and expensive for adoption.

HOOSICK FALLS, N. Y.—At a special election Nov. 19 the taxpayers voted 286 to 81 in favor of the proposed system of sewers, and bids will soon be asked for the construction. The total length is about 13 miles, and the estimated cost upward of $40,000, as stated in our issue of Sept. 8.

ROCHESTER, N. Y.—The East Side Trunk Sewer Commission will receive bids until Dec. 8 for section 4 of the trunk sewer.

SARATOGA SPRINGS, N. Y.—The Board of Trustees will receive bids until Dec. 12 for a pipe sewer in North St.

STAMFORD, N. Y.—A special election was held Nov. 30 to vote on the issue of bonds for $12,000 for a sewer system.

PATERSON, N. J.—The question of improved sewage disposal is being considered. The sewage is supposed to be carried to tidewater by means of the river, but, as a matter of fact, Mayor Beveridge says, most of it remains within the city limits during a greater part of the year. The Mayor has submitted five methods for remedying this evil: 1, The construction of a sewer parallel with the river; or in the bed of the river, in order to afford opportunities for periodical flushing. 2, The flushing of the river by means of the construction of gates in the Dundee dam, which would require the consent of the Dundee Water Power & Land Co. 3, The removal of the Dundee dam, which would require the sanction of the legislature. 4, The periodic flushing of the river from the Falls, or the filling of the holes in the bed of the river where pools of stagnant water are, which would be the least expensive of any of the methods. 5, The destruction of the sewage, which would, perhaps, be the most satisfactory settlement of the matter. Aldermen Rear, Ashley and Chitty were appointed a special committee, with the City Counsel to investigate the matter.

BERWICK, PA.—Alexander Potter is making preliminary surveys for a system of sewers. The separate system will be used. The population is about 3,300. About 9½ miles of sewers will be laid, and the discharge will be into the Susquehanna River.

MIDDLETOWN, PA.—Alexander Potter is making a report and estimate of cost of the St. Catherine St. sewer district. A brick sewer about 4 ft. in diameter and about a mile long will be required.

JACKSONVILLE, FLA.—Plans have been accepted for extending the present sewers 50 ft. beyond the end of the wharves, and $5,000 appropriated for the work.

CLEVELAND, O.—Plans have been prepared for sewers in five streets.

FORT WAYNE, IND.—Bids are asked until Dec. 13 for one mile of 6 ft. double-ring brick sewer. F. M. Randall, Cy. Engr.

WESTON SPRINGS, ILL.—It is reported that a system of sewers to cost $160,000 will be constructed.

RACINE, WIS.—Two brick sewers are to be constructed at an estimated cost of $41,000.

OTTUMWA, IA.—The City Engineer will receive bids until Dec. 5 for two 12-in. sewers.

KEOKUK, IA.—Bids are asked until Dec. 5 for tile sewers. W. H. Jones, Cy. Engr.

WATERLOO, IA.—The City has decided to commence the construction of a sewer system. The city will be divided into four districts, and the sewers will be paid for by assessment and the issue of bonds.

KANSAS CITY, MO.—Bids will be received by John Donnelly, Cy. Engr., until Dec. 6, for extending the O. K. Creek sewer. The ordinance against the joint intercepting sewer has been repealed, and the proposed sewer, for which this city will appropriate $10,000, and Kansas City, Kan., $8,000, is not only a possibility, but a probability.

KANSAS CITY, MO.—The Council has appropriated $10,000 for a sewer along the old Missouri River bank, from Santa Fe. St. to Genesee St.

OKLAHOMA CITY, OKLA.—J. A. Courtney, Cy. Engr., estimates the cost of proposed extensions at $15,000.

HOUSTON, TEX.—The following bids were received for sewers in LeBranch St. and Capitol Ave.; R. C. Storrie, $13,050; Donley & Conners, $18,450; W. S. Hipp, $20,301; Isaac Heffron, $20,679; Downey Bros., $28,186.

LOS ANGELES, CAL.—The following bids were received for the construction of the outfall sewer; the bidders being of this city, except Hughes & Mayer, Pasadena, and the California Bridge Co., San Francisco: California Bridge Co., section 1, $28,158 ($4,000 less for concrete instead of brick); section 2, $28,920 ($5,000 less for concrete); section 3, $35,300 ($6,500 less for concrete); section 7, $30,252 ($7,000 less for concrete); section 8, $30,596 ($6,000 less for concrete); additional excavation, 30 cts. per cu. yd. Campbell & Wood: 1, $20,285; 2, $32,950; 8, $32,785; 7, $38,200; 4, $45,000; extra excavation, 30 to 35 cts. Hughes & Mayer: 1, $17,157; 2, brick conduit, $25,357, or concrete conduit, $16,780; 5, $31,039; 7, brick conduit, $28,977, or concrete, $21,715; 8, brick conduit, $24,602, or concrete, $18,847; 9, brick conduit, $11,556, or concrete, $9,292. J. L. Mansfield: 1, sewer complete, $5.47 per lin. ft.; manholes, $60; 4, $4.25 per ft.; 2, $4.65 per ft. C. D. Vincent: 9, of brick, complete except tunnels, $17,643; 8, $27,654; 7, $33,091; 5, $37,242; 4, $37,000. Osborn & Apman: 8, $6.53½ per lin. ft.; 9, complete, $20,423; 7, $6.09½ per lin. ft. R. L. Bell, A. McNally, J. C. Haskell, Frank Young, J. C. Allent, Michael Stephan: 1, 2, 4, 5, 7, 8, 9, complete, $184,991. John Rebman: 1, $12,012; 2, $31,178; 4, $37,814; 3, $36,080; 7, $34,164; 8, $26,605; 9, (tunnels excepted), $31,552. F. N. Townsend: 9, $11,248; 4, $25,394; 8, $19,815. Froch Bros.: 2, brick, $22,885, or concrete, $19,840; 4, brick, $29,740; 5, $24,730; 7, brick, $27,454; or concrete, $21,771; 8, brick, $25,238; or concrete, $19,483; 9, brick, $11,216, or concrete, $9,131. C. M. Baker: 2, $25,548; 5, $34,121; 7, $23,168. Hobson & Wilkerson: 8, brick, $27,600, or concrete, $21,000; 7, brick, $32,200, or concrete, $24,500; 5, brick, $42,500, or concrete, $41,000; 2, brick, $26,800, or concrete, $19,600; 1, brick, $15,000. Duvall, Mills & Co.: 1, $17,000; 2, brick, $29,833, or cement, $25,654; 4, brick, $38,044; 5, brick, $34,015; 7, brick, $41,940, or concrete, $35,000; 8, brick, $33,631, or concrete, $27,768; 9, brick, $23,000, or concrete, $20,002.

MODESTO, CAL.—At a special election, Nov. 19, the city voted to issue bonds for $25,000 for a sewerage system.

SANTA BARBARA, CAL.—The City Engineer has prepared estimates for 9,756 lin. ft. of 6 and 8-in. sewers, to cost about $13,000.

WHATCOM, WASH.—The City Council has authorized the construction of a sewer tunnel to cost $20,000 by day labor under the direction of the Sewer Committee.

### STREETS.

BANGOR, ME.—Bids are asked until Dec. 10 for 115,000 granite paving blocks. C. W. Woodbury, St. Comr.

BROOKLYN, N. Y.—The Commissioner of City Works will receive bids until Dec. 8 for grading and paving Prospect Ave., from Ninth Ave. to city line, with cobble stones.

COHOES, N. Y.—The City Clerk will receive bids until Dec. 6 for stone, asphalt, or Portland cement sidewalks in three streets.

NEW YORK, N. Y.—Bids will be received at the Department of Public Works until Dec. 13 for paving one street with asphalt and 13 streets with granite blocks.

SARATOGA SPRINGS, N. Y.—The Street Commissioners will receive bids until Dec. 5 for flagging, curbing and paving.

ATLANTIC CITY, N. J.—The City Council will soon award a contract for the rebuilding of Pacific Ave. with gravel, at a cost of several thousand dollars.

EASTON, PA.—The City Council is considering ordinances for the paving of two streets with vitrified brick on a 6-in. base of concrete.

PHILADELPHIA, PA.—Preliminary surveys are being made for the proposed boulevard from the city hall to the park. Director Windrim estimates the cost of the boulevard at $6,000,000.

WILKESBARRE, PA.—The Street Committee has been authorized to receive bids for flagstone sidewalk, vitrified brick or granolithic gutter, etc., around the court house yard. W. H. Sturdevant, Co. Engr.

WASHINGTON, D. C.—The District Commissioners will receive bids until Dec. 10 for furnishing paving brick.

NEW ORLEANS, LA.—The City Comptroller has been authorized to advertise bids for paving Rampart St., between Dumaine and Esplanade Sts.

WINTON PLACE, O.—The Village Clerk will receive bids until Dec. 13 for the improvement of Fairview Ave.

MUNCIE, IND.—The City Clerk will receive bids for grading and paving sidewalks with brick.

FORT HOWARD, WIS.—The city has voted to issue bonds for $15,000 for public improvements.

MINNEAPOLIS, MINN.—The City Engineer has prepared surveys for the laying out and extending of five streets.

KANSAS CITY, MO.—Bids will be received until Dec. 6 for grading, macadamizing and paving. John Donnelly, Cy. Engr.

WEBB CITY, MO.—Bids are asked until Jan. 2 for the construction of sidewalks. H. B. Fraser, Cy. Engr.

GALVESTON, TEX.—The Board of Public Works has been authorized to advertise for 20 days for paving, each bid to be accompanied by a cash deposit of $5,000.

WAXAHACHIE, TEX.—It is reported that the streets of this place are to be paved.

DENVER, COLO.—The Board of Public Works will receive bids until Dec. 20 for paving Blake St. The estimated cost is $50,429.

SANTA BARBARA, CAL.—The City Engineer has prepared estimates for sidewalks and paving to cost about $22,000.

HALIFAX, N. S.—F. W. W. Doane, Cy. Engr., reports that the proposed paving of lower Water St. with wooden blocks will cost $49,500, or $61,000 with a concrete foundation.

## ELECTRICAL.

PORTSMOUTH, N. H.—It is reported that a new plant will be constructed at a cost of $300,000.

MANCHESTER, MASS.—The citizens of South Manchester have appropriated $4,000 for the maintenance of an electric light plant.

BATAVIA, N. Y.—Bids have been opened for the construction of a municipal plant. The Batavia Electric Light Co. offered to light the streets for five years at $8,000 per year, but it is thought that an addition can be built to the water-works, a complete plant put in and equipped for $20,000, and the expenses of lighting reduced to about $5,000 per year. The Board of Aldermen has voted to call a special election of the taxpayers to vote on the issue of bonds for $20,000 for the installation of a Brush electric light plant. The bid of the Brush Electric Light Co., Cleveland, O., was to furnish two 50-light dynamos, 80 lamps, 18 miles of wire, Corliss engine, pump, and everything necessary for a complete plant, except building, boiler and poles, for $14,970; to put everything in shape, to run and superintendent the running for 30 days, and also to protect the village from liability in case of accident of any kind.

MONROE, N. C.—The citizens have voted to issue bonds for $15,000 for the equipment of an electric light plant.

SAVANNAH, GA.—A syndicate of business men has purchased the electric railway, and will put in an electric light and power plant near the present powerhouse of the railway, at an estimated cost of $250,000. Orders will soon be placed for two 1,300-light incandescent, and two 50-light arc dynamos, and two 250-HP. engines and boilers.

CARTHAGE, O.—The Board of Directors of Longview Asylum will receive bids until Dec. 27 for engines, belting and steam piping, dynamos, switchboard and apparatus, and for wiring, lamps and sockets.

CLEVELAND, O.—The Board of Control will receive bids until Dec. 21 for 220 or more electric lights for lighting the city for one year from Jan. 1, 1893.

KOKOMO, IND.—The contract for street lighting for five years has been awarded to the Kokomo Electric Co. at $80 per light per year. The Thomson-Houston system will be used. A company representing the Western Electric system offered a bid of $78.50, but the working of this system at the Diamond plate-glass works in this city was not satisfactory to a majority of the Council.

DETROIT, MICH.—Bids will soon be asked for 30 days for lighting the streets by electricity.

HILLSDALE, MICH.—The city has voted to issue bonds for $15,000, to erect and maintain a municipal plant.

GRAFTON, N. DAK.—The plant of the electric light company is to be enlarged.

COLUMBIA, MO.—The City Council has granted a 20-year franchise for an electric light and water-works plant to W. I. Anderson, St. Louis. The plant will be constructed at once.

YOAKUM, TEX.—An electric light plant will be constructed. About three miles of wire will be strung, and it is intended to have the system completed within 90 days.

GLOBEVILLE, COLO.—The Town Board has contracted for 12 lights at $12.50 each per month.

REDLANDS, CAL.—The Redlands Electric Light & Power Co., recently organized, offers to furnish the city 40 lights of 2,000 c. p. each, at $10.50 per light per month.

TUMWATER, WASH.—The Olympia Light & Power Co. contemplates improvements in its plant, to cost from $10,000 to $15,000.

COBOURG, ONT.—The Town Clerk will receive bids until Dec. 5 for lighting the streets of the town; also for an electric light plant with a capacity of 30 arc lights of 2,000 c. p. each.

MONTREAL, QUE.—The Committee on Light has recommended that the contract for street lighting for ten years from Jan. 1, 1894, be awarded to the Royal Electric Co., at $124.10 per light per year for 5 yrs., $120.45 for 3 yrs., and $116.80 per light per year for the remaining 2 yrs. This company is now paid $146.10 per light per year and offers to reduce the price to $124.10 per light for next year, which will save the city about $22,000, provided the proposed contract is awarded. The first offer of the company for a new contract was $130 per light per year for 20 yrs. The Thomson-Houston system is used.

NEW COMPANIES.—Columbia Electric Light Co., Philadelphia, Pa.; $100,000; Treas., Fred E. Coward. Electric Exhibition Co., of New York, Newark, N. J.; $100,000; to manufacture and deal in electrical novelties; Jos. Livingstone and Theo. Hillman, New York, and Arthur Schwarz, Newark. Mississippi River Electrical Steamboat Co., St. Louis, Mo.; $7,000,000; to build a fleet of passenger and freight boats to be run by electricity; Pres., H. H. Liemke. Climax Electric Light Co., Chicago, Ill.; $100,000; J. R. Bensley, G. F. Watson, A. J. Vaughn.

## CONTRACT PRICES.

HARBOR IMPROVEMENT.—San Francisco, Cal.—Bids were opened by Maj. W. H. Heuer, Nov. 14, for the improvement of Humboldt harbor. The estimated cost of the improvement is $1,750,000, and it is thought that five years will be required to complete the work. The bidders were as follows: 1, McKay & Warren, San Francisco; 2, J. C. Bull, Jr., Arcata; 3, H. Krusi, San Francisco; 4, C. A. Hooper, San Francisco; 5, N. J. Blagen, Portland, Ore.; 6, Hughes Bros. & Bangs, Syracuse, N. Y.; 7, J. N. & J. G. Day, San Francisco; 8, Pacific Coast Construction Co., Eureka. The bids are given in this order: A, 1,000 ft. single track railway on shore, per lin. ft.; B, 2,000 ft. double track railway; C, 11,000 ft. double track railway and trestle; D, 120,000 cu. yds. brush mats in place, per cu. yd.; E, 350,000 tons rock, per ton; F, 3,700 lin. ft. single track railway on south jetty; G, 3,700 lin. ft. moved and relaid; H, piles, driving and ready for capping, per pile; I, pine caps, per lin. ft.; J, pine stringers; K, ties for single track; L, ties for double track; M, taking up old rails and laying new.

| | A. | B. | C. | D. | E. | F. |
|---|---|---|---|---|---|---|
| 1 | $5.00 | $10.00 | $15.00 | $1.50 | $1.79 | $2.50 |
| 2 | 2.50 | 5.00 | 8.00 | 1.34 | 1.34 | 2.50 |
| 3 | 2.00 | 3.00 | 10.00 | 1.90 | 2.30 | 2.00 |
| 4 | 1.50 | 3.00 | 11.00 | 1.50 | 2.59 | 2.50 |
| 5 | 2.00 | 3.75 | 9.00 | 1.25 | 1.60 | 3.00 |
| 6 | 2.75 | 5.50 | 12.00 | 1.68 | 2.98 | 3.50 |
| 7 | 1.86 | 3.72 | 7.40 | 1.15 | 1.50 | 2.10 |
| 8 | 2.50 | 5.00 | 7.25 | 1.49 | 1.75 | 1.50 |

| G. | H. | I. cts. | J. | K. | L. | M. | Total. |
|---|---|---|---|---|---|---|---|
| $ .60 | $18. | 40 | $ .50 | $ .30 | $ .65 | $ .60 | $1,007,970 |
| .30 | 12. | 50 | .75 | .50 | 1.00 | .60 | 740,600 |
| .50 | 20. | 50 | .50 | .40 | .80 | 2.00 | 1,160,250 |
| 1.00 | 25. | 80 | 1.00 | 1.00 | 3.00 | .60 | 1,227,450 |
| 1.60 | 16. | 65 | .75 | .65 | 1.00 | .60 | 835,520 |
| 1.50 | 25. | 50 | .60 | .80 | 1.60 | .75 | 1,408,850 |
| .55 | 20. | 18 | .75 | 1.00 | 2.00 | .65 | 783,503 |
| .40 | 11. | 65 | .40 | .57 | 1.00 | .45 | 890,580 |

DREDGING.—Portland, Me.—Lt.-Col. Peter C. Hains opened bids Nov. 16 for dredging, as follows: A, Upper Sands Bar, 45,000 cu. yds.; B, Kennebec River, shoals at and above Gardiner, 75,000 cu. yds.; C, Penobscot River, 46,000 cu. yds.; D, Cocheco River, N. H., 10,000 cu. yds.; E, Bellamy River, N. H., 35,000 cu. yds.; F, Harbor of Refuge, at Little Harbor, N. H., 150,000 cu. yds.; G, York harbor, Me., entrance, 6,000 cu. yds.; H, York harbor, basin, 20,000 cu. yds.; I, Narraganugus River, Me., 60,000 cu. yds.; K, harbor at Portland, Me., 11,000 cu. yds.; L, in Back Cove, Portland, Me., 110,000 cu. yds.; M, Saco River, Cow island, 45,000 cu. yds.; N, Saco River, outlet bar, 15,000 cu. yds.; O, Saco River, boulders, 350 cu. yds.; P, harbor at Camden, Me., 60,000 cu. yds.; Q, Harrasecket River, Me., 150,000 cu. yds.

The bids were as follows: Charles H. Souther, Boston, Mass., A, 34 cts.; B, 49 cts.; C, 49 cts.; D, $1.57; E, 34 cts.; F, 24.5 cts.; G, 77 cts.; H, 41 cts.; I, 34 cts.; K, 34 cts.; L, 26 cts.; M, 52 cts.; N, $1.02; O, 83 cts.; P, 36 cts.; Q, 28 cts.

Metropolitan Dredging Co., Lynn, Mass., A, 34 cts.; B, 55 cts.; C, 44 cts.; E, 35 cts.; F, 25.5 cts.; I, 27 cts.; K, 30 cts.; L, 26 cts.; M, 47 cts.; N, 98 cts.; O, $1.25; P, 27.5 cts.; Q, 28 cts.

A. B. Martin, Boston, Mass., A, 39 cts.; B, 50 cts.; C, 52 cts.; D, $1.40; E, 29 cts.; F, 23.5 cts.; G, 68 cts.; H, 36 cts.; I, 35 cts.; K, 35 cts.; L, 30 cts.; M, 50 cts.; N, $1; O, $1; P, 32 cts.; Q, 32 cts.

Moore & Wright, Portland, Me., A, 28 cts.; B, 40 cts.; C, 48 cts.; D, $1.40; E, 29 cts.; F, 23.5 cts.; G, 68 cts.; H, 36 cts.; I, 35 cts.; K, 30 cts.; L, 30 cts.; M, 50 cts.; N, 90 cts.; O, 75 cts.; P, 26 cts.; Q, 27 cts.

Hamilton & Sawyer, Chebeague, Me., M, 45 cts.; N, 98 cts.; O, 80 cts.; P, 25.75 cts.; Q, 28.5 cts.

WELLS.—Toledo, O.—The following contracts have been awarded by B. J. Beard for drilling artesian wells in Oregon township; Geo. Gladieux, East Toledo, two wells, 5⅝-in. double strength galvanized pipe for well complete with Rumsey pump No. 122, $1.30 per ft.; J. N. Gardner, East Toledo, four wells, 4-in. double strength galvanized pipe complete with Rumsey pump No. 122, $1.15 per ft.

WATER PIPE.—Sioux City, Ia.—The only bid received for the laying of water pipes on 21st St. was that of E. J. Hanlon, as follows: 18 tons of 6-in. pipe, $46 per ton; one 6-ft. hydrant, $45.

BASALT BLOCKS.—San Francisco, Cal.—A contract for furnishing basalt blocks has been awarded to E. R. Thomssen at $33½ per M.

STREET WORK.—York, Pa.—The contract for paving four squares on George and Market Sts. with asphalt has been awarded to Odenwalt & Huber at $2.97 per sq. yd.

## MISCELLANEOUS.

DRAINAGE CANAL.—Chicago, Ill.—At a meeting of the Drainage Board Nov. 23 the contract for a mile of the canal east of Willow Springs, section P., was formally awarded to Ricker, Lee & Co., at $470,040, and that for another mile near Willow Springs, section D., to E. D. Smith & Co., at $479,867. The lowest bids received for this work were published in our issue of Oct. 27, and notice of original award of contracts in our issue of Nov. 3. The Drainage Board has decided to readvertise for the work on sections A, B, C, and E, bids to be received until Jan. 25. Bids will also be received at the same time for the enlargement of the Illinois & Michigan Canal by dredging to a capacity of 100,000 cu. ft. per min. Further particulars will be found in our advertising columns.

DREDGING, ETC.—The following work will be done by the U. S. Engineer Corps, bids to be received at the dates specified: Piling, Ahnapee Harbor, Wis., Dec. 6; dredging and jetty work, Calcasieu River, La., Dec. 6; channel work, between Chicago, Duluth and Buffalo, Dec. 9-17. Dredging: Salem River, N. Y., Dec. 15; Winthrop Harbor, Mass., Dec. 15; Flushing Bay, N. Y., Dec. 16; Port Jefferson Inlet, N. Y., Dec. 16; Chicago Harbor, Ill., Dec. 17; Gowanus Bay, N. Y., Dec. 21. Oak timber, Mt. Carmel, Ill., Dec. 20. Dikes, etc., Gray's Harbor, Wash., Dec. 21.

GARBAGE FURNACE.—Waco, Tex.—The City Council will receive bids for 60 days for a 75-ft. garbage furnace. The Brownlee Garbage Furnace Co., Dallas, has offered to construct such a furnace for $7,500.

STREET LIGHTING.—Cleveland, O.—The Board of Control will receive bids until Dec. 21 for about 4,000 vapor, gasoline, or oil lamps, for street lighting for one year.

JAIL.—Plaquemine, La.—Bids will be received until Dec. 10 for a new jail for Iberville parish. A. H. Gay, Chn. Building Com.

DIKE BONDS.—New Westminster, B. C.—Bids are asked until Dec. 31 for $80,000 of bonds to be issued by the Maple Ridge Diking Commissioners. A. G. Gamble, Clk. Comrs.

GARBAGE DISPOSAL.—Indianapolis, Ind.—The Board of Public Works is considering specifications for the disposal of garbage and night-soil. The contract will be for ten years.

LOCKS.—Portland, Ore.—The lowest bid for the completion of the Cascade locks was that of J. G. & I. N. Day, San Francisco, Cal., $1,521,285, and the bid has been recommended for acceptance.

## MANUFACTURING AND TECHNICAL.

LOCOMOTIVES.—The Brooks Locomotive Works, Dunkirk, N. Y., have built 10 switching engines for the Cleveland, Cincinnati, Chicago & St. Louis, and are building 10 switching engines for the Lake Shore & Michigan Southern, 10 passenger engines for the Buffalo, Rochester & Pittsburg, and 25 freight engines for the Great Northern. The Schenectady Locomotive Works, Schenectady, N. Y., are building 10 passenger engines for the Cleveland, Cincinnati, St. Louis & Chicago, and two switching engines for the St. Louis Railway Terminal Association. The Rhode Island Locomotive Works, Providence, R. I., have an order for 10 consolidation engines for the Fitchburg. The Manchester Locomotive Works, Manchester, N. H., have an order for 5 eight-wheel passenger engines for the Old Colony. The Missouri Pacific has placed orders for 50 engines. The Great Northern will add 20 mogul freight engines and 30 heavy passenger engines to its equipment. The St. Paul, & Duluth will place orders for a heavy switching engine.

CARS.—The Missouri Car & Foundry Co., St. Louis, Mo., is building 500 box cars and 150 furniture cars for the Pennsylvania. The Gilbert Car Mfg. Co., Troy, N. Y., has an order from the New York Central for 50 passenger cars 54 ft. long, 30 baggage cars 60 ft. long, 20 smoking cars 54 ft. long, 20 vestibuled passenger cars 60 ft. long, and 10 combination cars 60 ft. long. The Terre Haute Car Co., Terre Haute, Ind., is delivering 1,200 freight cars, with automatic couplers and air brakes, to the St. Louis, Vandalia & Terre Haute. The Harvey Steel Car & Repair Co., Harvey, Ill., is building a number of dump cars. The J. G. Brill Co., Philadelphia, Pa., has built 24 electric cars for Toledo, O. The Brownell Car Co., St. Louis, Mo., has an order for 20 electric cars for Cincinnati, O., and has built 20 "accelerator" electric cars for Columbus, O. The Chesapeake & Ohio will add 1,000 box cars to its equipment. The Monterey & Mexican Gulf will purchase a large amount of new rolling stock. The Missouri Pacific has placed orders for 28 passenger cars, 5 chair cars and 12 sleeping cars.

RAILS.—Carroll Bros., Buffalo, N. Y., are in the market for second hand steel rails.

THE FRANK-KNEELAND MACHINE CO. has been organized at Pittsburg, Pa., and has established works on its property of 6½ acres at 54th St. and the Allegheny Valley R. R. The foundry is being equipped with electric traveling cranes, regenerative gas furnaces, drying ovens, casting pits and other appliances. The machine shop will have an electric traveling crane, a full line of machine tools, and extra powerful roll turning lathes of the company's design. Pres. and Gen. Man., I. W. Frank; Secy., Edward Kneeland.

THE KING BRIDGE CO., Cleveland, O., is furnishing several iron and steel roofs and a hoisting and conveying plant for handling ore, coal, etc., at the new docks of the Pittsburg, Shenango & Lake Erie, at Conneaut, O.

NEW COMPANIES.—Hollenback Frog & Switch Co., Chicago, Ill.; $100,000; Wesley Hollenback, Thomas H. Brown and R. R. Bemiss; this is a reorganization of the old company. R. S. Hunt & Sons Co., Weymouth, Mass.; to manufacture railway track torpedoes, etc.; $50,000; Pres., Edmund S. Hunt. Brewer Car Axle-Box Co., Chicago, Ill.; $5,000,000; E. R. Brewer, C. P. Burdick and A. G. Thompson. Perforated Metallic Street Crossing Co., Chicago, Ill.; $100,000; Frank M. Potter, H. L. Hoepner and Wm. Wilhartz. Suspension Arch Fireproofing Co., Chicago, Ill.; $300,000; F. T. Debong, H. M. Chase and H. R. Pearson. Columbian Iron & Steel Co., Chicago, Ill.; $5,000,000; G. J. Hibbard, T. A. Hibbard and J. K. Hamilton. Granite Mineral Wool Co., St. Louis, Mo.; $25,000; Hugh M. Thompson, F. J. Hunlett and Alex. Fitzpatrick. American Asphaltum Co., Chicago, Ill.; $40,000; W. H. Collins, C. M. Farnum and R. J. Hirsch. Nelson Car Coupling Co., Omaha, Neb.; $100,000; S. P. Nelson, John T. Helin and John S. Holland.

## CURRENT PRICES.

RAILS.—New York: $30 at eastern mills, $30.75 at tidewater; girder rails, $36 to $39; old rails, $17 for iron, and $14.50 to $15 for steel. Pittsburg: $30; old rails, $21 for iron and $15.50 to $16 for steel. Chicago: $31 to $32.50; light rails, $32; old rails, $18.50 to $19 for iron, and $13 to $14.50 for steel.

TRACK MATERIAL.—New York: steel angle bars, 1.6 to 1.65 cts.; spikes, 1.9 to 2 cts.; track bolts, 2.4 to 2.6 cts. with square and 2.7 to 2.8 with hexagon nuts. Pittsburg: splice bars, 1.75 to 1.77 cts. for iron and 1.8 cts. for steel; iron and steel spikes, 2.15 cts.; iron track bolts, 2.7 cts. with square and 2.8 cts. with hexagon nuts. Chicago: splice bars, 1.75 to 1.8 cts. for iron and steel; spikes, 2.05 to 2.1 cts. at mill; track bolts, 2.65 to 2.75 cts. with hexagon nuts.

PIPE.—Cast iron, $20 to $30 per ton. Wrought iron, discounts as follows at Pittsburg: 55% and 10%, and 47½% and 10% on black and galvanized butt welded; 65% and 10%, and 55% and 10% on black and galvanized lap welded. Casing, 57½%.

FOUNDRY PIG IRON.—New York: $13.50 to $15.50. Pittsburg: $13 to $14.25. Chicago: $13.25 to $14.25.

LEAD.—New York: 3.8 to 3.85 cts.; Chicago: 3.72 to 3.75 cts.; St. Louis: 3.57 cts.

STRUCTURAL MATERIAL.—New York: beams, 2.2 to 2.25 cts. for large lots, and 2.35 to 2.75 cts. for small lots; channels, 2.25 to 2.5 cts.; angles, 1.95 to 2 cts.; tees, 2.3 to 2.75 cts.; sheared iron plates, 1.85 to 2.1 cts.; steel plates, 1.9 to 2 cts. for tank, 2.2 to 2.25 cts. for shell, 2.5 to 2.65 cts. for flange, 3 to 3.25 cts. for firebox. Pittsburg: beams, 2 to 2.1 cts. for large lots, and 2.2 to 2.25 cts. for small lots; channels, 2 to 2.1 cts. for large lots, and 2.2 to 2.25 cts. for small lots; angles, 1.85 to 2 cts.; tees, 2.25 to 2.35 cts.; Z-bars, 2 to 2.05 cts.; universal mill plates, 1.75 to 1.85 cts. for steel; sheared steel bridge plates, 2.1 to 2.25 cts.; refined bars, 1.7 cts. for iron and steel; steel plates, 1.75 to 2 cts. for tank, 2 to 2.25 for shell, 2.1 to 2.2 cts. for flange, 3.5 to 3.75 cts. for firebox, 2 to 2.1 cts. for bridge. Chicago: beams, 2.27 to 2.35 cts. for large lots, and 2.5 to 2.75 cts. for small lots; channels, 2.27 to 2.35 cts. for large lots, and 2.45 to 2.75 cts. for small lots; angles, 1.9 to 2 cts. for large lots, and 2 to 2.35 cts. for small lots; tees, 2.2 to 2.3 cts.; universal plates, 2.05 to 2.15 cts.; steel plates, 2.1 to 2.15 cts. for tank, 2.17 to 2.25 cts. for shell, 2.3 to 3.4 cts. for flange, 2.7 to 2.8 cts. for firebox.